THE BACKWARD CHILD

SIR CYRIL BURT

111/SIE-111

STATE INSTITUTE F EDUCATION
BANIPUR

THE BACKWARD CHILD

WORKS BY THE SAME AUTHOR

THE YOUNG DELINQUENT

THE FACTORS OF THE MIND

THE SUBNORMAL MIND

THE DISTRIBUTION AND RELATION OF EDUCATIONAL ABILITIES

MENTAL AND SCHOLASTIC TESTS

HANDBOOK OF TESTS FOR USE IN SCHOOLS

THE MEASUREMENT OF MENTAL CAPACITIES

HOW THE MIND WORKS

THE CAUSES AND TREATMENT OF BACKWARDNESS

'Educationally Retarded at School Leaving Age.'
Boy aged 14. Mental age, 11; educational age, $8\frac{1}{2}$.

[*Frontispiece*

THE BACKWARD CHILD

BY

SIR CYRIL BURT

D.Sc. (Oxon), Hon. LL.D. (Aberdeen), Hon. Litt.D. (Reading)

FELLOW OF THE BRITISH ACADEMY
HONORARY FELLOW, JESUS COLLEGE, OXFORD
EMERITUS PROFESSOR OF PSYCHOLOGY, UNIVERSITY OF LONDON
FORMERLY PSYCHOLOGIST TO THE LONDON COUNTY COUNCIL

STATE INSTITUTE OF EDUCATION
BANIPUR

UNIVERSITY OF LONDON PRESS LTD
WARWICK SQUARE, LONDON, E.C.4

FIRST EDITION 1937
Reprinted 1942
SECOND EDITION 1946
THIRD EDITION 1950
Reprinted 1951
FOURTH EDITION 1958
FIFTH EDITION 1961

~~5754~~
5854

PRINTED IN GREAT BRITAIN BY
LOWE AND BRYDONE (PRINTERS) LIMITED, LONDON, N.W.10

PREFACE TO FOURTH EDITION

THE passing of the Education Act in 1944 marks a great advance in the provision to be made for the different types of children discussed in this book. Under the general heading of 'educationally subnormal' are now to be grouped all who are gravely backward in educational attainments, no matter what may be the cause, provided they are (in the technical sense) 'educable.' The category thus defined coincides almost exactly with what the teacher has been accustomed to call 'the backward child.'

During the past few years nearly all the larger educational authorities have taken active steps to put into force the main provisions laid down in the Act; and most of the additions and changes introduced into the present edition are the outcome of the further experience thus gained. The basic principle advocated in earlier editions of this book, namely, that the certification of educable defectives should be abolished and all forms of retardation treated as a part of a single administrative problem, has now been accepted. Accordingly, the detailed arguments in favour of such a policy have been abridged, and the practical questions raised by the new requirements more fully discussed.

December, 1957 C. B.

PREFACE TO FIFTH EDITION

IN revising this book for a fifth edition a few changes have been made, partly to incorporate the results of recent research, and partly to clarify passages that some of my many correspondents have found obscure. I shall gratefully welcome further criticisms or suggestions.

May, 1961 C. B.

PREFACE

In publishing this book I am continuing my original purpose of attempting to describe, group by group, the main forms of mental subnormality to be met with among children of school age. In an earlier work on delinquents I dealt with those who are morally subnormal: in the present volume I shall deal with those who are subnormal intellectually—with the backward and the dull.

The task of coping with such children falls chiefly on the teacher in the ordinary elementary school. It is to teachers, therefore, that these pages are primarily addressed. How to distinguish the backward from the normal, what to do with them when discovered, how to classify, treat, and train them—these are questions that teachers are continually asking, and they are questions that are bound to arise under any scheme of universal education. But the practical difficulties cannot be satisfactorily solved until certain preliminary points, of a more theoretical nature, have first of all been settled: what is meant by backwardness, what forms does it take, how far can the different forms be cured, and, above all, what are its predominant causes? In education as in medicine, in training the mind as in healing the body, efficient practice is to be achieved only by a scientific approach. Accordingly, throughout my discussion I have sought to keep in view a double aim, and to be at once scientific and practical.

Old and time-honoured as it must seem to the schoolmaster, the problem of the backward child has never been attacked by systematic research until quite recently. We know little about causes, and still less about treatment. Defects of intelligence, of memory, of attention, poor sight, poor hearing, prolonged ill-health, tonsils and adenoids, all the petty ailments so prevalent among children from the slums—conditions such as these are constantly

noted by the teacher or the doctor, and continually put forward as causes of backwardness in school work: yet hitherto no one has rigorously verified their influence, or traced precisely how each operates in the individual child. Hence, at the very outset of my work for the London schools, I found it necessary to undertake a first-hand investigation upon these more fundamental questions. With the generous aid of the teachers themselves a series of surveys was planned. We began by inquiring how many children were definitely backward and what were the special handicaps from which they suffered; and then, by keeping the same groups under continued observation, we went on to ascertain how far they improved with this or that mode of treatment, and how their ultimate progress, during childhood and in after life, compared with that of the average pupil.

The results of the earlier inquiries quickly showed that the subject was much more complex than had previously been assumed, and that the policy commonly advocated was far too simple. With special medical treatment and special educational coaching—if possible in a special class wherever the numbers were large—most of the backward pupils, so it was generally supposed, could be gradually brought up to the normal level. Our ultimate conclusions introduce so many modifications into this traditional view that it may be helpful to summarize in advance the main points of divergence.

First, the application of psychological tests proves beyond all question that, in well over half the backward cases, the child's whole intellectual capacity is definitely below the normal. Since this general disability is inborn, if not actually inherited, the backwardness is irremediable. For cases such as these, therefore, our whole educational aim must be altered. Secondly, there are undoubtedly a large number of children in whom the mental disability is more specific. A weak memory, a feeble power of concentration, an incapacity for abstract reasoning, a marked instability of temperament or character—some special shortcoming of this kind, whatever its underlying nature, may frequently be observed in a child whose

general intelligence is perfectly sound. Such conditions, however, evidently play a smaller and a more elusive part. Only in about one-sixth of the total number do they form the sole or the most obvious cause; and then, it would seem, they seldom offer an insuperable barrier to educational progress: with a suitable change of teaching methods their effects can be circumvented. Thirdly, though the vast majority of backward children—80 per cent. in an area like London—prove to be suffering from minor bodily ailments or from continued ill-health, nevertheless general physical weakness is rarely the main factor. Far more important, from the standpoint of classroom instruction, are the more limited and specialized defects of sense and muscular co-ordination—defects of sight, hearing, speech, and hand-movement.

For most of these physical defects (as they are somewhat loosely called), both general and specific, the usual recommendation is again a special school or special class—open-air schools for the delicate, speech-centres for the stammerers, special classes or schools for the dim-sighted and the partly deaf: in America there are even training classes for the left-handed. But a closer survey reveals an unexpected situation. Defects of this sort, as found in backward children, are far too slight and far too common to be dealt with systematically by a separate centre for each group. Moreover, it is not so much the defect in itself, it is the occurrence of the defect in a child already somewhat dull and unadaptive that is the essential source of failure.

These mixed types are the most numerous and the most puzzling of all: and here my conclusions, though somewhat novel, are, I think, unavoidable. Instead of treating such a child primarily as a case of this or that peculiar defect accompanied incidentally by backwardness, and sending him to a special centre according to the nature of his defect, we should, so I have argued, treat him primarily as a case of backwardness, recognizing the defect as one of many contributory causes. To require the speech-specialist at the centre to study the peculiar needs of each dullard, and adapt his methods accordingly, is hardly a feasible proposal; but we may reasonably expect the

teacher of the backward class to borrow, and where necessary to modify, the specialist's methods of speech-training in dealing with the children in his care. That, at any rate, is the plan which my own experience has found to be the more successful in all but the severest cases; and that certainly is the solution which is most in the interests of the child himself.

With this general policy in view, I have carried out a number of incidental inquiries into the most effective modes of training that can be employed with such children. Since stammering and left-handedness are the defects that seem to cause most trouble both to the teacher and to the child, particular attention has been devoted to these two conditions; and the various devices for teaching the fundamental subjects—reading, spelling, and arithmetic—to those who are weak in one branch alone have been tested and compared. In these supplementary studies of the more specialized types of backwardness, I have been greatly indebted to the help given by my former research students at the Institute of Education, often themselves teachers of considerable experience, who have, in pursuance of a general scheme, co-operated in post-graduate research on a co-ordinated list of problems.

Within the school itself the chief factor proves to be, not so much inefficient teaching, but what may be broadly described as inadequate organization—lack of a systematic method for detecting the potentially backward at a sufficiently early age, failure to adapt the teaching methods to the peculiar needs of each child, ill-timed promotion, ill-timed change of method or curriculum following removal from one class, one school, or one department to another, and finally (a factor which differs considerably in different areas) irregular attendance. But far more often, we shall discover, the essential causes lie wholly beyond the school walls: so that the problem of the backward child is as much a social as an educational issue.

The causes of backwardness are thus exceedingly various: and, in nearly every instance, not one factor, but a combination of factors, lies at the root of the trouble. Throughout this volume, therefore, the main emphasis will be

placed, not on the coaching, but on the study, of the individual child.

The formation of backward classes—or, in the senior school, of a 'stream' of backward or 'C' classes—is without question an urgent need. It is, nevertheless, but the first preliminary. The crucial problem still remains—what to do with the backward pupils themselves when we have relieved the other classes of their presence. Accordingly, my survey of causes will be followed by a review of the different forms of treatment; and I shall conclude by describing in concrete detail the classification, the curriculum, the time-table, the general teaching-methods, suitable for the commoner types, and—what I take to be the supreme essential—the selection and training of the teacher. After reviewing these special requirements, we shall see that many of them, though not perhaps all, can to some extent be met even in the ordinary classroom.

I must, however, insist that success will always depend upon the care with which such changes are adjusted to the needs of the individual. In all the inquiries I have made, one conclusion consistently stands out as of supreme importance. Every case is unique; and there can be no sure method of treatment without a thorough investigation of each backward pupil, an investigation which must follow systematic lines, briefer perhaps and less elaborate than those here described, but no less scientific, an investigation too which every teacher must carry out for himself. One of my chief aims, therefore, has been to make the teacher his own psychologist.

The sister art of medicine has largely been built up by the investigations of the practising doctor reported in professional journals; and of recent years teachers have shown a similar desire to undertake educational researches of their own. To stimulate and assist in such inquiries is an incidental object of this book. No one is in a better position to advance the cause of education as a science than the schoolmaster. In the records compiled by individual teachers, in the data accumulated at medical inspections, in the tables and case-histories published from time to time in educational journals and in annual reports, we

might hope to find much first-hand information on the problems here discussed. In the course of my work I have made a thorough scrutiny of all the accessible literature; but, more often than not, owing to a neglect of the simplest conditions, such accounts prove to be valuable rather as a description of personal impressions and professional experience than as a report of scientifically planned inquiries. Teachers themselves are beginning to realize that, in education as elsewhere, if a research and its findings are to carry conviction, scientific precautions must be observed; and nowadays they often turn to the psychologist for advice on experimental or statistical technique. Accordingly, besides summarizing the actual conclusions reached by my collaborators and myself, I have briefly reviewed the best methods of inquiry that seem to be at present available, and have sought to show how the theoretical study of such problems may prove quite as fascinating as the practical, and at times far more productive. The simpler modes of testing are described in detail. The statistical issues, though intelligible enough to the teacher with mathematical training, have been relegated to an appendix.

To combine a bird's-eye view with a microscopic has proved no easy task. Others besides the practising or intending teacher are interested in the backward child. Social workers, medical officers, and at times even the intelligent parent, are eager to learn what reasons may be assigned for backward development in individual cases, and what is the outlook, or the best form of treatment, for this child or for that. In the text, therefore, I have endeavoured to avoid all needless technicality, and to write so that a clear understanding of the subject shall not be confined solely to those engaged professionally in education. The reader who looks for fuller evidence, or desires to learn more about special topics or particular problems, will find help in the selected references cited towards the end of each chapter and in the detailed discussions of the footnotes.

To keep the book within reasonable dimensions, I have omitted the numerous portraits and case-descriptions with

which a lengthier work might have been enlivened. It may, I think, be safely assumed that the teacher who is interested in these children and perplexed by their difficulties will be able to supply, at first hand and from his own experience, concrete examples that will sufficiently illustrate the various groups I shall describe. With the student in training it is different. At most of our modern training colleges the courses on educational psychology are now beginning to lay more and more emphasis on the study of the individual child, instead of merely expounding the abstract nature of the human mind and the general principles of teaching. Should the book be used to supplement such lectures, I would venture to make one urgent plea: the mere description of methods and types should always be illustrated by clinical demonstrations of actual cases, and by a selection of typical children whom the students may study and test.

An apology is due for the delay in publication. Although most of my surveys were carried out while I was Psychologist to the Education Department of the London County Council, it is only recently that I have been able to attack the statistical analysis of the data. To the numerous teachers, medical officers, care committee workers, and research students who have assisted me in investigating particular cases or particular problems, or have allowed me to discuss with them special aspects of the work, and above all to my secretary, Miss G. Bruce, whose assistance has been invaluable at every stage, I have to express my sincerest thanks. Finally, I have once again to acknowledge my indebtedness to the London County Council for permission to introduce statistics and to incorporate material from my official reports. The samples of handwriting and drawing, reproduced in figures 4, 5, and 11, are taken from L.C.C. *Report No.* 2052 on 'Mental and Scholastic Tests' (1921), originally published by the Council and now issued by Messrs. P. S. King & Son: and the University of London Press wishes to acknowledge the courtesy of Messrs. P. S. King & Son in lending the three plates.

University College, London. C. B.
May 1937.

CONTENTS

TABLES

DIAGRAMS AND ILLUSTRATIONS

CHAPTER I

THE CLASSIFICATION OF SUBNORMAL CHILDREN

A Backward Class.—The problem of the subnormal child confronts the teacher in many different guises; and it may be well at the outset to obtain some rough but concrete picture of the various types to be met with. Let me take, by way of illustration, one of the earliest groups that I was led to study, since it will enable us to observe how backward individuals, first encountered as young pupils in the class-room, may develop or deteriorate as time goes on, and to see what kind of men and women they eventually become when they grow up to maturity and take their places as workers and citizens in a wider world.

The school was a large one, situated in a big industrial city of the north, and, like many others in such areas, was recruited from families of a widely differing stamp: to the front it faced a well-to-do working-class neighbourhood; at the back it looked out on a poverty-stricken slum. When I first visited it, nearly a quarter of a century ago, a new headmaster had recently been appointed; and, soon after his arrival, the eight assistants had risen in mild revolt: one and all had protested that good work was impossible in any of the classes, owing to the presence of two or three hopeless dunces in each room, hindering and hampering the progress of the rest. The headmaster accordingly made a survey of the whole school. The more difficult cases were sorted out, and assembled in a separate classroom with a teacher of their own. And thus was established what would nowadays be called a 'special class for difficult children'—one of the earliest of its kind in the country.

This class, like the rest of the department, was 'mixed'; that is to say, children of both sexes were taught side by side. The faces of the thirty-two boys and girls, as they giggled or glared from the benches in front of us, seemed

at once so typical and yet so peculiar, each wearing the impress of its own individuality, that, like a naturalist on the watch for instructive specimens, I offered to make a psychological study of every child. I was permitted to begin by testing and interviewing all the pupils in the class. Gradually complete case-histories were collected and filed; and from that day to this I have tried to keep in touch with each one, though they have long ago left school and found their level in the community at large. For this small group, therefore, my records now extend over a period of nearly twenty-five years.

At the time of my first visit the majority of the children were doing the work of a poor Standard II—lessons which should easily be managed by an average pupil of 8; their actual ages by the register ranged from 7 to 14½. The oldest was a heavy, hulking lad named Arthur, already beyond the school-leaving age. Years ago he had reached his mental limit, and was now marking time. It was clear that he would end his education unable to do the simplest sums in money or to read the names of the neighbouring streets. Neither of his parents could write or sign a letter; his two elder brothers were casual labourers of the dullest type, incapable of anything but unskilled work at the wharf or on the road; and an uncle and an older cousin were in an asylum for imbeciles. Arthur, indeed, should have been certified as feebleminded as soon as he reached the senior department, and sent at the age of 7 or 8 to a special school for the mentally defective.

George, his chief companion, an overgrown boy of 12, seemed, so far as work in class was concerned, almost as incompetent; yet at home, in the street, and in the playground, he was full of resource and common sense. So far from suffering from poverty, he was the son of a well-to-do tradesman; and two of his brothers had lately won scholarships. George himself, so I found, had been absent from school during earlier years owing to a series of infectious illnesses. After recovering he preferred playing in the road to working in the classroom; so that, out of eight years of school life, the young truant had never been in attendance for more than six months together.

The two youngest, Willie and Walter, were rascals of a very different nature. Sharp little arabs of $7\frac{1}{2}$, they were not really backward ; they were merely troublesome. They stole ; they bullied ; they ran away from home ; they were centres of commotion wherever they went. An inspector had urged their removal to the upper school, because they were far too shrewd and unruly for a class in the infants' department.

Of the girls, the oldest, Clara, was a smart and smiling chatterbox of $13\frac{1}{2}$. She was formerly in Standard VI, and proved quite able to read a Standard VI textbook ; her spelling, her English compositions, her knowledge of history and geography, were unexpectedly good. But the simplest of sums on paper had always been beyond her ; and so, in view of her hopeless arithmetic, it had been thought inadvisable to keep her in the higher class. The dullest of the girls were twins of 11. They were cousins of the boy I have called Arthur ; but were neither so inert nor so unteachable as he. And, as they had three more years of growth in front of them, there was still some slender chance that they might make further progress.

The brightest of the whole group was Dick, an undersized youngster of 10, the son of a dock labourer who was out of employment for two-thirds of his time. Nimble enough with his fingers and his tongue, Dick found the same trouble in reading as Clara with her sums. Yet, judged by tests of innate ability, and by his practical behaviour in out-of-school life, his intelligence was well above the level of an ordinary child of 10. He could write fluent but ill-spelt English ; and his answers to my problems showed that he unquestionably had the capacity to think in terms of number ; yet, in the daily work of the classroom, his inability to read had prevented him from picking up the orthography of any but the easiest words, and kept him from understanding the printed exercises in arithmetic that he had been set to work out. Hence, to a superficial eye, he seemed backward all round ; and his blotted and slovenly copy-book, heavily scored with the teacher's blue pencil, was held out to me as the worst in the class. The rest of the children, when closely studied,

differed almost as much from each other as those I have named and described in detail. Between Dick, who was really bright, and Arthur, who was almost feebleminded, nearly every grade of mental capacity was here represented.

After-histories.—What has education done for such children as these ? Through the kindly efforts of the head-master, I have since been able to follow up the after-history of every member of the group. Their subsequent careers were as diversified as their characters while still at school. The two little 7-year-old scapegraces stopped their truancy, but obstinately continued to steal. At length, one was committed to a training ship, but ran away soon after, and has since been lost to sight ; the other, now a married man of 30, is at this moment in gaol for theft. Arthur, the dullest in the class, obtained five different jobs within the first twelve months, but failed to keep one of them for more than a couple of weeks. He, too, soon found his way to the police court. Loafing and unemployed for over a year, he eventually fell into the clutches of an unscrupulous gang, who egged him on to petty burglary, and kept the proceeds for themselves. He was sent, however, not to prison, but to sea ; and it was afterwards reported that, in climbing the rigging, he made some thoughtless or clumsy movement, tumbled overboard, and was drowned.

George, on the other hand, during his last two years at school, made such rapid progress that he was able to pass out as a normal child, and to obtain a good post as a clerk. He is now works' manager in his father's firm, earning a salary twice as large as that of the teacher who taught him. The twins made some slight improvement in the special class. On leaving both secured employment, the one in a factory and the other as a domestic servant. Each stuck to her place for four or five years ; but both subsequently married, and now have dull children of their own.

Clara became a typist. Her first situation she held for three years ; her second she lost because, having no head for arithmetic, she was unable to keep the accounts which formed part of her clerical duties. Ultimately, she exchanged the office for the stage, and appeared behind the footlights as a chorus-girl. Dick started as a carter in the

docks with his father. Later on he became a motor-mechanic for a firm near-by; and now has a flourishing business of his own. Of the other children there are eighteen whose careers I have since traced: their work ranges from that of a casual labourer paving roads to that of an electrical engineer; and their wages from 30*s.* a week to £500 a year.

Here, then, is a picture of our problem. It is clear at the start that a group of school children singled out by a teacher as backward or dull may, when viewed from a closer standpoint, comprise individuals of very different types. As the headmaster observed when describing his new class, such a set is 'as mixed as any menagerie.' In some cases, an irreparable handicap, imposed by Nature at birth, seems undoubtedly to blame; and the dull pupil grows up into a dull and inefficient citizen. In others, poverty, ill-health, or ill-luck, has produced a backwardness that can certainly be removed, if only the cause is first discovered and a proper treatment prescribed. Our task, therefore, is to consider how the different types may be distinguished, and to discuss what is the most effective way to handle each case.

Fundamental Distinctions.—The first question must be one of classification. To treat such children in the mass is like providing the same diet for all the animals in the Zoo. No plan can be successful, and every effort will be thrown away, unless we possess some practical scheme, however rough and ready, whereby these exceptional children may be sifted, sorted, and provisionally reclassed.

Among those who are mentally subnormal, what types or groupings can we distinguish? From the standpoint both of the teacher and of the school psychologist, the most helpful classification is one that is based upon a trio of theoretical distinctions. The broad lines of division will be these. We may distinguish, first, between intellectual defects and those that are moral or temperamental; secondly, between defects that are inborn and those that are acquired; thirdly, between those that are general and those that are limited or specific. This threefold contrast is something more than an erudite restatement of popular

or traditional antitheses. It emerges from the results of recent research, checked and corroborated by the most careful experimental and statistical devices. As yet, it must be admitted, the evidence is still presumptive rather than conclusive ; but the conclusions as I have stated them are about as scientific as any wide generalizations on human nature can at present profess to be.[1]

(i) *Intellectual Subnormality as Distinguished from Temperamental.*—To begin with, then, children who are subnormal in intellectual activities must be considered apart from those who are subnormal in temperament. Unless the pupils are first picked out on the basis of careful testing, every backward class and nearly every special school is likely to receive cases where the trouble is at bottom more a problem of character than of intellectual incapacity. In the group I have just described, the two little 7-year-old scamps, who were doing Standard II work, were by no means backward in intelligence. The head teacher had labelled them ' defective ' ; but he explained that by this he meant morally defective, not mentally defective. They were, as he put it, criminals in the bud ; and, soon after, it was necessary to remove them from the backward class altogether owing to their corrupting influence on the discipline of older and duller lads.

With the detection and treatment of temperamental subnormality I have dealt elsewhere. Here our task is to do the same for the various forms of intellectual subnormality. The word ' intellect ' I use somewhat broadly. I have taken it to cover all those mental processes that are concerned with knowing rather than with feeling or with willing—with what is technically termed the cognitive aspect of the mind as distinct from its affective and conative aspects. It includes, not only what is ordinarily described as in-

[1] The grounds for this analysis of mental processes I have brought together in a small publication called *The Measurement of Mental Capacities : A Review of the Psychology of Individual Differences* (Oliver & Boyd, 1927). With the classification and diagnosis of mental subnormality generally I have dealt in my book on *The Subnormal Mind* (Oxford University Press, 1935). Here I am concerned only to summarize the underlying principles quite briefly, and to deal in rather fuller detail with those practical aspects of the problem that present themselves to the teacher.

tellectual work in a somewhat narrow sense—reading, writing, learning the English language, or solving arithmetical problems—but also more practical activities, such as cooking, carpentering, or managing a house—handwork as well as headwork, doing as well as thinking, so far as these practical processes are controlled, implicitly or explicitly, by perception and thought. Thus a child who is seriously lacking either in manual dexterity or in common sense will be regarded as intellectually subnormal, quite as much as a child who is unable to read, or spell, or work out his sums.

Children who are intellectually subnormal in the sense just defined may, for the moment, be named briefly the 'backward.' It is with this wider connotation that I have used the word for the title of this book. In itself the term 'backward' embodies a helpful empirical conclusion: *Nearly all the intellectual abnormalities to be met among school children manifest themselves primarily by a delay or an arrest in mental progress.* They depend upon differences of degree rather than of kind. In intelligence, in knowledge, and in school capacity, the subnormal child resembles—at many points, though admittedly not all—an ordinary child who is two or three years younger than himself. This fact is often interpreted by saying that the boy who is intellectually subnormal is suffering from slow mental development; his intellectual growth has not kept pace with his years. Accordingly, a more exact and technical phrase is sometimes adopted to designate the whole group: they may be called 'retarded children.' Words like 'slow' or 'retarded,' however, must not of necessity be taken to imply that, if left to go at his own easy pace, the backward child will in the end catch up. Whether he can do so or not must in the last resort depend on whether his backwardness is mainly inborn.

(ii) *Innate Subnormality as distinguished from Acquired.*—Intellectual retardation may assume many different forms. From one child to another, it may vary in extent, in intensity, or in origin. We come thus to our second main distinction, the distinction between what is inborn and what is acquired. The actual knowledge that a boy displays in school—his proficiency in spelling, his power to

add or multiply, his acquaintance with the dates in history or with places on the map—these are all acquisitions : they are the accumulated effects of instruction, of learning through memory and practice. But the capacity enabling him to make such acquisitions is more fundamental. It is part of his congenital endowment ; it is bestowed on him at birth, and, like all such qualities, may vary profoundly from one child to another. 'Some boys,' says the old choirmaster in *The Way of all Flesh*, 'are born stupid—and that might be thee, Jim ; some achieve stupidity—for thou hast greatly increased thy birthright ; and some have stupidity thrust upon them, which, an it please the Lord, shall never be thy case.' And, in accord with these very sound distinctions, we must inquire, with every backward lad—how far is the child's present backwardness really innate, how far is it attributable to circumstances operating since his birth, and how far is it a joint result of causes of both kinds ?

The answer will make a world of difference in the treatment of certain pupils. A deficiency that is inborn or inherited can never be cured ; a shortcoming that is not inherent, but springs simply from lack of health, from lack of opportunity, or from some such accidental cause, is, in theory at any rate, remediable. The children just described exemplify the distinction. The majority no doubt were hybrids—nature and nurture both contributing in various proportions. Arthur and his 11-year-old cousins were plain examples of an innate and incurable incompetence—an incompetence running all through the family. Dick and George, on the other hand, were specimens of a purely temporary retardation ; each subsequently recovered his normal status, like a cutting from a healthy tree, blighted in the early season, but later sprouting up and bearing good fruit, once it has been bedded out and tended with expert care.

We have, therefore, to discriminate, so far as we are able, between the boy who *cannot* learn, except within the narrowest limits, and the boy who *can* learn, but for some reason or other has never actually done so. The former may be called 'innately retarded,' or, in one word, 'dull' ;

the latter 'educationally retarded' or '*merely* backward,' implying by this phrase that the child is backward in school work only and not in natural development. To deal with both these types side by side with the normal in the same school or class with one and the same curriculum is almost a hopeless task. No grindstone can make a good blade out of bad metal; and no amount of coaching will ever transform the inborn dullard into a normal child. The pupil who is merely backward forms a different problem. He is a knife without an edge—good steel that has never been sharpened. He hacks away at his daily loaf; but will never cut true or smooth until he has been sent off to the repair shop to be whetted and set straight.

(iii) *General Subnormality as distinguished from Specific.*—The third distinction is that between general and specific abilities. The hypothesis of general ability is one of the most fruitful that has emanated from recent psychological research. To a greater or a less extent, all intellectual abilities appear to be correlated one with another. On the average and in the long run, a child who is efficient in one form of work tends to be efficient in the rest. The child who is backward in reading proves, more often than not, to be backward in spelling, arithmetic, English composition, and, indeed, in almost every subject of the elementary curriculum. Whatever mental process we examine, a single, central factor seems to pervade and permeate them all.

The view is as old as Aristotle.[1] It is implicit in our current schemes of examination and educational organization. We choose our scholarship candidates by a test in English and arithmetic, and expect them later on to be capable of advanced instruction in all the various branches of the secondary school syllabus. We subject our brightest youths to an examination in highly academic subjects, and by that means hope to discover the future administrators for the Government service. In the elementary school a pupil is retained in one and the same standard for each of

[1] *Nic. Ethics*, VI, vii, 2: Εἶναι δέ τινας σοφοὺς οἰόμεθα ὅλως, οὐ κατὰ μέρος. ('There are some who are wholly wise, not wise only in some partial direction.')

the subjects of the time-table ; and the mentally defective are sorted out and sent to special schools on the assumption that they are, for educational purposes, equally defective all round.

Whether or not this thesis holds of adults and of higher levels of achievement (and most psychologists believe it does), it certainly holds good for children ; and nowhere is it exemplified more plainly than among the dull, the backward, and the feebleminded. It is a truth demonstrated by the results of psychological testing applied to thousands of school pupils.[1] In nine cases out of ten, children who can do only one thing well, and are useless at everything else, seldom do that one thing so well as their fellows. The tenth case is the case of special aptitude, operating over and above the more general ability—an exception that we must turn to later on.

This general intellectual factor, central and all-pervading, shows a further characteristic, also disclosed by testing and

[1] Here Galton was the pioneer, as in so much else : he was the first to propose a convenient unit for assessing general ability, the first to suggest that it might be measured by psychological tests, and the first to devise the coefficient of correlation for estimating the importance of the causal factors common to two or more measurements. The earliest systematic applications of Galton's correlational technique (as modified by Pearson) to the results of psychological testing were those of Wissler, who attributes the suggestion to J. M. Cattell, a pupil of Galton's. Wissler's aim was to devise a method whereby ' the fundamental elements of general and specific ability can be isolated and valued.' (*Psych. Mon. Sup.*, 1901.) The plan was to observe (i) whether the correlations were all positive (that, he argued, would indicate the presence of a ' general ability ') and (ii) whether some were disproportionately high (that would indicate the presence of ' special abilities '). A few years later (1904) Spearman reported test-results to show (i) that there was a ' fundamental function common to all intellectual activities ' which he identified with ' general sensory discrimination,' but (ii) that the influence of specific abilities was ' vanishingly minute.' Spearman, however, used only tests of sensory discrimination.

In 1907, with the aid of Dr. Flugel and later of Mr. R. C. Moore, I applied tests to every level of cognitive process, and found common factors entering into all. The ' highest common factor ' appeared to be mainly inherited, and therefore identifiable with what Galton had termed ' natural ability ' and Binet ' general intelligence.' The researches of a large succession of teachers, trained in psychological methods, seem now to have put these conclusions beyond a doubt. Cf. L.C.C. Report on *Distribution and Relation of Abilities* (1917) ; and for an account of the arguments and methods employed, see below, p. 463 and pp. 683–4.

statistics. It appears to be inherited, or at least inborn. Neither knowledge nor practice, neither interest nor industry, will avail to increase it. So far as it can be said to depend on any definable cause, it appears to vary chiefly with similar variations in other members of the same family, and therefore is presumably handed on by parents to their offspring at birth. For the rest its distribution follows mainly the laws of chance.

This all-important capacity is usually denominated by one word—'intelligence.' *Intelligence may thus be conveniently defined as innate, all-round, intellectual efficiency.*[1] It follows that every mental performance must turn upon at least two factors—first, the universal factor of general intelligence, the same in every process; secondly, a more limited factor or group of factors, which differ according to the nature of the particular task, and may therefore be identified with special aptitude or talent.

If, then, the mind comprises both general intelligence and specific aptitudes, inherent backwardness may arise in two ways: it may arise either from an inferiority in the general factor, and so show itself in all directions; or it may arise from an inferiority in one or other among the special factors, in which case it may be restricted to certain subjects alone. Hence, we reach a corresponding division of defects or disabilities. They may be either general or limited: general and widespread, when they spring from undeveloped intelligence; limited and narrow, when they spring from a lack of some specialized aptitude. The dull and the mentally deficient are inferior all round. Like Arthur and the 11-year-old twins, they prove irredeemably obtuse in whatever situation intelligence may be required. As a result, in every subject of the curriculum, and in all the situations of later life, they fall hopelessly below the average of their fellows. Those, on the other hand, who are the victims of nothing but some special disability—Clara, for example, who could do everything but sums, or

[1] This is virtually the definition adopted by Galton and Binet. For the evidence see below, chap. XII. Unfortunately during recent years the word 'intelligence' has come to be used in so many senses that it might be well to drop it altogether.

Dick who failed solely where reading was required—these are primarily backward in one school subject only, or in one type of mental process and no others.

(iv) *The Dull as distinguished from the Defective.*—The three distinctions that I have just discussed relate exclusively to the nature or the kind of subnormality. But subnormalities differ not merely in kind; they also differ in degree. With Arthur and his girl cousins, the subnormality in each instance was of the same general, all-pervasive character; but with the boy it was far deeper and more intense. The girls were not so utterly dull as to make no progress at all in the ordinary school, nor were they incapable in later years of earning their own livelihood. Arthur, on the other hand, was too helpless and hopeless even for a special class of backward children; and, when grown up, still wanted care and supervision to preserve him from the risks and dangers to which he so often succumbed.

Thus, as regards the amount of innate, all-round ability, a child may be either slightly retarded, or retarded to a serious and extreme degree. Those whose intelligence is so gravely impaired that in the ordinary school they remain unteachable, and in after life are quite incapable of adapting themselves to ordinary social and economic requirements, are officially described as 'mentally defective.' In the first Act of Parliament passed to provide for such cases, they were expressly distinguished from those who are 'merely dull or backward.' Children, therefore, who, by comparison, seem less seriously retarded than the mentally deficient, may be called the 'merely dull.'

Here an obvious question arises. How far must a child fall below the average standard for us to consider him technically a retarded case? And what further degree of retardation must be established before we can consider him, not merely dull, but definitely defective, and suitable for a special school? In short, where are the lines of demarcation to be drawn? To be accurate and fair to all, the borderlines must be laid down in quantitative terms, and a good deal of preliminary investigation will be needed. Hence these are problems that we must for the moment adjourn until we have considered

the more scientific methods of mental measurement and testing.

Summary.—Although, then, the problem of the 'difficult pupil' confronts the teacher in a bewildering variety of guises, nevertheless, as his experience increases, he begins to discern resemblances, and to recognize recurring identities among the different individuals. The same cases seem to present themselves time after time, like supernumeraries at a provincial theatre who cross behind the scenes and come round again and again in an apparently interminable procession. Some of them he soon learns to identify almost at a glance; to others he will tentatively allot some classifying nickname of his own.

The classification I have suggested as best for most practical purposes may be summarized as follows. First, what I have called intellectual subnormality can generally be distinguished from moral or temperamental subnormality; and then those whose subnormality is mainly or primarily intellectual may be conveniently divided into four provisional groups: (1) the 'defective,' whose disability is innate and general, and at the same time extreme; (2) the 'dull,' whose disability is also innate and general, but far less severe; (3) the educationally retarded or 'merely backward,' whose disabilities are not innate but acquired; and (4) the rarer cases of 'specific disability,' whose defect is not general but limited.

But, before applying this classification, a word of caution must be sounded. The scientific reader will fight shy of an alluring assumption—the idea that all living persons can be sorted, ticketed, and pigeon-holed, as samples of some clear-cut, well-marked type. In human nature there are no such things as types; there are only tendencies. The points and peculiarities that distinguish, within a single group, the various individuals who together compose it are often quite as striking as those that distinguish one group from another: the groups themselves melt each into its neighbour by almost imperceptible gradations. Thus the classifications of individual psychology are chosen for their convenience rather than for their finality: they are meant to answer the needs of daily life rather than to reflect

any sharp lines of cleavage laid down by nature.

Nevertheless, every science must begin by classifying the things it deals with. In those sciences that deal with simple substances or simple organisms, such as chemistry or botany, we can sort the substances or the plants into fairly definite categories, each qualitatively different from the rest. When we try to classify human beings, however, the salient characteristics take the form of quantitative variables rather than of discrete qualities, and the different traits are too closely interdependent to be distinguished by mere observation or separated by experimental devices. We are, therefore, compelled to employ statistical procedures. The discovery of the most useful principles of classification is the task of what is now called 'factor analysis.'[1] It is this procedure, aided and checked by clinical observation and by ingenious experiments, which has led to the fundamental distinctions which I have just described, and has thus helped us to discover the chief independent key-qualities of the mind and the most effective methods for classifying pupils, whether normal or subnormal.

The lines of division, however, are by no means clear-cut. The defective merge into the dull, and the dull into the normal: those who are subnormal intellectually may display subnormalities in temperament as well, and, time after time, it proves almost impossible to decide whether a particular child's backwardness springs chiefly from innate and ineradicable weakness, or from environmental handicaps, or from both conspiring together towards the same unhappy result. Each child, therefore, must be considered as a unique individual. His psychological classification is nothing but a means to an end, a practical aid rather than an indisputable point of scientific diagnosis.

[1] For an elementary explanation of this procedure, see below, Appendix III, pp. 675–84.

CHAPTER II

THE DISCOVERY AND INVESTIGATION OF BACKWARD CASES

(A) *The Choice of Units*

Mental Tests and their Value.—I have sketched, in brief and abstract outline, a theory of the general classification of retarded children. Let us now turn to actual practice. What serviceable steps can the teacher take to meet this perennial problem ?

The first and most important thing to do with the backward child is to discover him. And the discovery must be made at the earliest possible moment. It is precisely here that the psychologist's devices come to the teacher's aid. Nothing is so speedy or so effective as a system of standardized tests.

The advantages of such tests are obvious to all who have used them. First of all, tests are time-savers. They cannot, indeed, pretend to greater accuracy than the considered opinion of the observant and experienced master, in touch with his pupils term after term. But observation is slow, and experience a matter of years. The prime requisite is to detect the dull or the deficient on the day they first enter the classroom ; and this the young teacher needs to do as well as the older and more experienced. To give each newcomer an equal chance upon probation, and to wait for a year or more until the defect has grown so glaring that no one could possibly doubt it and the child himself is becoming a nuisance and a drag—such a plan may sound safe and prudent and perhaps more kindly to the child : but it involves a fatal delay. In education as in medicine, early diagnosis is essential. Some quick provisional method for sizing up each entrant on the spot is therefore an urgent need ; and this can be readily achieved with a systematic scheme of testing.

Secondly, such tests provide a uniform standard of measurement. The mere opinion of a teacher, however experienced, is bound to be vague, and to vary from one man to another. The tests, on the other hand, are based on objective experiments, carried out on an extensive scale; and their results are formulated in precise numerical terms. It is their object to show, by an exact and reliable figure, what level should be attained at any particular age by the average child, and how far a given individual falls below that requirement. So long as teachers and school medical officers adhere solely to the uncertain methods of the ordinary interview, trusting to their personal experience for their standards and to their private impressions for their judgments, the same boy will be marked down as mentally defective by one, and passed by another as an ordinary slum youngster. Where standardized tests are employed, there is one weight and one measure; and the verdict reached should be the same with all examiners.

Thirdly, a series of systematic tests enables us to explore the child's mind more methodically. By their means we can ascertain the special nature of his peculiar disabilities, and locate their probable cause. As a result, we may be able to discriminate, with some degree of assurance, between a backwardness which is acquired and so presumably removable and one which rests on an inherent defect of the mind. Above all, they reveal the child's good points and strong capacities, as well as the weaknesses and the gaps, and so indicate on what qualities of mind or character we may rely to compensate for minor failings that are in themselves beyond repair.

Mental Measurement.—The value, then, of psychological testing is threefold: it is swift; it is standardized; it is systematic. And these merits are achieved by one and the same ruling principle—a principle that is essential in psychology as in every other branch of science: the use of a quantitative technique. The primary aim of mental tests is to take each mental capacity in turn and measure it.

But, it may be objected, how is it possible to split up and subject to actual measurement a thing so subtle and elusive as the mind? What unit can we use? Does psychology

claim to sum up the soul of a child in a bare arithmetical formula, like so many pounds of mutton or so many pints of milk ?

In answer, let us first of all remember that mental measurement is not the startling innovation it is sometimes thought to be. Every school examination, every list of marks, aims at measuring some quality of mind. The psychologist claims no more than this : to do with greater precision what all school examiners have been doing year after year. Nor is a mental unit very difficult to discover. Several possibilities at once suggest themselves ; and, before he can appreciate the basis on which existing tests have been drawn up, the teacher must have some general notion of the more scientific units that have been proposed and used.

Marks.—Until recently the only units with which teachers were familiar were the arbitrary units known as marks. These seek to measure a pupil's ability, either from zero (taken as denoting absolute ignorance) or from a maximum (taken as denoting a completely satisfactory performance in all the items of the test). But plainly such a scale is a mere *ad hoc* improvisation, with no objective meaning. If with a given test—say a simple paper in arithmetic—a child gets no marks, because all his sums are wrong, it is still conceivable that with an easier set of sums he would have earned at least a few marks ; if, on the other hand, he gets full marks and so scores 100 per cent., it is possible that with a harder test, or with a larger number of problems, he would have obtained only 80 or 90 per cent. And with a test of reading or English composition, who shall decide what kind of performance is to be regarded as perfect and therefore meriting the maximum, and what is to be regarded as deserving a nought and therefore equivalent to no performance at all ?

The fact is that the teacher's common notion of marking —to measure so much performed out of so much possible, and thus to indicate such and such actual capacity out of a maximum of so much—is, from a scientific standpoint, wholly unworkable, if only because there can be no assignable upper limit to what the best may conceivably do. Perfection does not exist and cannot be defined. Even if

we take the greatest genius who has yet been born—Shakespeare, shall we say—as signalizing the highest pinnacle of actual achievement, some day a greater than Shakespeare may arise. And just as there is no upper limit, so there is no lower limit. Who will define the absolute zero for intelligence ? The most helpless idiot that ever lived, tested at the hour of birth, would still show some positive and measurable trace : yet would anyone think of descending so low in searching for a zero-point to measure the child at school ?

The fact is that marks for mental capacity must always be relative, never absolute ; they can only indicate that A is better as compared with B, not as compared with a fixed or independent standard. To use a familiar mathematical distinction, marks are really ordinal numbers, not cardinal. They indicate position, not quantity. They are primarily a means of arranging the examinees in an order of merit. And the notion of relative order rather than of absolute amount must form the true starting-point for every system of mental measurement.

1. Statistical Units

All the more exact forms of psychological marking and assessment have in fact been based on this device of ranking—that is, on grading by relative place. Any teacher can draw up his pupils in order of their ability for the subjects that he teaches ; and whatever can be ranked in order is susceptible of measurement. We have only to make the scale more precise.

To arrange a group of children accurately in order of merit two points must be borne in mind : (i) First of all, the most stable measurement that can be procured with a set of comparable groups is not the maximum or the minimum, but the average. This, therefore, is the best basis for comparisons between one group and another or between the individuals in any single group. Consider all the 10-year-olds to be found in your department year after year. From one year to another the brightest and the dullest—the top boy and the bottom—will vary enormously. But, unless the method of recruitment is changed, the

average boy—that is, the middle boy, or 'median' as the statistician would call him—will remain pretty much the same in each successive group. (ii) Again, children near the middle or average are far more numerous than those near either end of the scale. The differences between the first boy and the second, and between the bottom boy and the bottom but one, are much wider than the differences between the children near the middle of the list. Hence in ranking a given group in order of merit, the teacher should begin from the two opposites and work towards the middle. The best boy is always one of the easiest to single out; but so also is the worst.

If, however, we seek to use the unit of rank as itself a unit of measurement, several difficulties present themselves. To begin with, unless special adjustments are made, the significance of the figures must alter with the number in the group: in a class of only ten children the position of tenth is the lowest of all; in a school of five hundred it would denote a high place. Secondly, since medium children differ less amongst themselves than the best do or the worst, it follows that the intervals between each rank and the next, taken in successive pairs, are of very different sizes: they are large at the top, and get progressively smaller towards the centre, and then pull out again like a telescope towards the lower end. Everyone has noticed how, when a number of boys are running a race, the fastest get well spaced apart, whereas the average runners cluster in a bunch, and the slowest stragglers come trailing in, with longer and longer distances between them. The same thing happens during mental development. It is an example of a far-reaching law: in almost every form of measurement, physical as well as mental, wherever either the capacity measured or the measurement itself is subject to chance variations, slight divergences from the central tendency are far more numerous than large, and the larger the divergence the rarer it is.[1]

[1] The reader is probably already acquainted with this law under the name of the 'General Law of Error': as usually stated, it declares that the frequency or the probability (p) of any given deviation or error (d) is a function of the square, or at any rate some even power, of the deviation itself: *i.e.*, $p = Ke^{-kd^2}$ (where K and k are constants whose value is essentially deter-

Thus the ideal form of measurement for the psychologist must be based, not on the particular order of merit obtained by simply numbering off the individuals in front of us like soldiers on a drill parade, but on a *spaced* order of merit which will always have reference to a conventional group *of standard size.*

To fulfil this double requirement, and so overcome the twin defects of the ordinary method of ranking, various statistical expedients have been suggested.

(i) *Percentile Ranks.*—First of all, imagine a typical sample of children comprising exactly one hundred individuals, all arranged in a descending series according to their mental powers. We may then allot to any given child a letter or a label, a number or a mark, showing his position in this graduated group ; and, provided our sample is really typical,[1] the scale will be applicable to all children of the same age.

By way of illustration, let us try this method with the

mined by what is termed the 'standard' deviation). In this form the law —sometimes called the normal law of error—is commonly attributed to the German mathematician Gauss, and hence often known as the Gaussian law : it could with greater justice be attributed to the French mathematician Laplace, who first gave it the familiar integral form ; or better still to Newton's friend and contemporary, De Moivre, a Fellow of our own Royal Society, who first derived the logarithmic form from the binomial expansion.

Almost any book of mathematical tables will give figures for the exponential function—that is, a table to find e^{-x} when x is known : but, to save the continual multiplication by constants, special statistical tables have been drawn up (in terms of $d = \sqrt{2x}$ and $p = \cdot 3989\ e^{-x}$). The most convenient set is contained in Holzinger's *Statistical Tables for Students in Education and Psychology* (University of Chicago Press, 1925, 5*s*.).

If we assume that the distribution of intellectual abilities is determined, not exactly by chance in the statistician's sense—that is by an indefinitely large number of indefinitely small causes—but by a definite number of dominant and recessive genes, then the theoretical curve that can be deduced for such a distribution will resemble a normal curve slightly peaked and markedly skewed towards one extremity. For most practical purposes a normal distribution is sufficiently exact (see below, footnote 1, p. 25).

[1] The best method for ensuring this is (*a*) to make the sample large (and, for the present purpose, a hundred may be considered a large number), and (*b*) to select the individuals by sheer chance ; since, provided the total population remains unchanged, all large samples drawn at random tend to have the same average and the same general distribution.

5854 111

pupils of the special class described in the last chapter. Placed in a standard sequence of a hundred, the two little scapegraces of 7 would have ranked twelfth and fifteenth respectively, their intelligence, therefore, was quite high in the scale. Clara would have come fifty-third, and was consequently almost an average or middling child. The twins would both have been about ninetieth. And Arthur was easily last.

Any teacher of experience will see at once that the estimate thus conveyed for the intelligence of each child is far more precise and significant than any arbitrary mark like '15 out of 100,' or any verbal adjective like 'poor,' 'weak,' 'excellent,' or 'supernormal.' If the ratings are derived not from mere impression but from systematic testing, and if the scale has been fixed by trial, preferably repeated trial, upon samples truly representative, then the results will be as trustworthy as any psychological judgment could claim to be.

Such a method is called measurement by percentiles, *i.e.* by ordinal instead of cardinal percentages. As a mathematical contrivance it still has one drawback. By keeping to a group of standard size, namely, one hundred, we have certainly eliminated the effects of differing numbers; but we have not yet allowed for the contraction or expansion of the spaces between consecutive points on the scale. As I have just noted, in any random group the difference between the top child and the second is nearly always greater than the difference between the second and the third; it may be ten or fifteen times as large as the difference between the fiftieth and the fifty-first: indeed, about the centre, several children will generally be bracketed as ties. Towards the bottom, the intervals will gradually increase again, and the distance between the ninety-ninth and the hundredth will be as wide as the distance between the first and the second. For this reason, as we have seen, the ordinary rules of arithmetic will not apply to percentiles: they cannot be added or subtracted like simple marks.

(ii) *The Standard Deviation.*—This drawback, however, may be readily overcome by a second adjustment. By adopting certain simple and well justified assumptions, the

I.C.E.R.T West Bengal

differences between the percentiles may be translated into terms of some less elastic unit. Of these the best is the unit known to statisticians as the 'standard deviation.'[1] The standard deviation is merely a somewhat elaborate mode of calculating the average range or mean variation, that is to say, the average degree to which the individual members of a group deviate on either side of the grand average for the group as a whole.[2] Although the *total* range varies from one group to another, and generally increases with the

[1] The main assumption is that the ability measured is distributed in the form of what I have described above (pp. 19–20, footnote 1) as the 'normal' curve. When this is actually the case, percentiles can at once be converted into terms of the standard deviation by reference to a table of the normal probability integral: the table printed in Holzinger's little manual (*loc. cit. sup.*, pp. 70–4) is probably the most handy to use. If, as generally happens in tests with time-limits, the distribution proves to be a symmetrical, it may first be roughly adjusted to the 'normal' by taking a suitable logarithmic function of the original scores, or by some similar empirical device. Such remoter transformations, however, will probably be employed by none except the advanced investigator engaged on a scientific research.

[2] A footnote may be helpful to the reader who is unfamiliar with this simple statistical notion, and prefers a concrete illustration to the mathematical exposition of the technical textbook. Standard deviations will be referred to pretty frequently in the statistical analysis of my data; and it may therefore be worth while trying to explain the concept in some detail.

To the ordinary teacher the calculation of an average deviation is most familiar from the exercise which nearly every child in Standard VII carries out in computing daily or monthly fluctuations in temperature. He works out the 'mean variation' by taking the deviates about the general average and then averaging in turn the deviates themselves. Suppose he desires to compare the climate of London with that of Madeira. He will first work out the general average for the whole year. During 1920, for example, the mean temperature in London was 51° F.; and subsequent averages show that from one year to another it rarely varies by more than half a degree. In Madeira the mean temperature was 64·6° F. But English weather, besides being cooler, is famous for its fickleness. How can we measure this? To note the hottest and the coldest days in a given year would be a very rough method, since the *extreme* variations, unlike the average, vary enormously. The *mean* variation, however, provides a more stable figure. For the year in question it was at London ± 6·8° F.; at Madeira ± 4·5° F.; and at Yakutsk ± 35° F. Hence Madeira has the more equable climate, while Yakutsk runs to violent excesses both of cold and of heat.

Now suppose we desire to compare some particular month for its erratic behaviour in regard to two different features—say temperature and hours of sunshine. We cannot contrast *degrees* of temperature with *hours* of sunshine:

magnitude of each group, the *average* range is tolerably constant. The technical meaning of standard deviation and its mode of calculation are matters that the non-statistical need not stay to understand; but the device itself suggests a principle of first importance in all psychological measurement. Nearly always the average of the group coincides with the figure for the central person in that group; and can be treated as marking the normal. *Individuals can then be measured in terms of their distance*

the two units are not comparable. But if we reduce both deviations to multiples of the corresponding mean variations, a comparison may be fairly made. In December 1920, the temperature in London sank to 40·6°, a drop of — 10·4° below the general mean, so that December on this occasion showed over 1½ times the average monthly variation: we might express it as — 1·47 m.v. The amount of sunshine was only 17·4 hours. Is this more or less than the drop in temperature? In terms of the mean variation we find it — 1·51 m.v., almost exactly the same figure as for temperature.

The '*standard* deviation' is simply a more convenient way of estimating the *average* deviation. It is the root-mean-square deviation. The individual deviations are first squared to abolish the differences of algebraic sign which in calculating the ordinary mean deviation are simply ignored; and then, to compensate, the square root is taken after averaging the several squares.

A related term of statistics that the reader will presently encounter is the 'probable error.' This is a third measure of variability, originally used where some indication of trustworthiness or 'probability' was desired. The 'probable error' is simply ·6745 × standard deviation (roughly two-thirds). Its import is instructive: add and subtract the probable error to and from the average, and you obtain two limiting figures within which just half the cases may be expected to fall. The reader will observe that the limits so given mark the 25th and the 75th percentiles; and the whole series is thus divided into four quarters, equal in number, by the three points which we may call (i) — 1 p.e. (25th percentile), (ii) the average (50th percentile), (iii) + 1 p.e. (75th percentile), respectively.

Those who wish to understand more of these fundamental statistical devices will find convenient summaries in most handbooks on educational measurement or mental testing. Of elementary books on psychological statistics, Dr. Shepherd Dawson's *Introduction to the Computation of Statistics* (University of London Press, 1933) is well suited to the needs of the ordinary student. For the non-mathematical teacher, perhaps the simplest and most accessible summary will be that given in Chapter VII of Ballard's *Mental Tests* (University of London Press, 1920). For the mathematician who desires to undertake some statistical inquiry of his own, the best all-round technical textbook is T. L. Kelley's *Statistical Method* (Macmillan Company, 1923).

above or below this average, which is usually described as the 'norm.'

The average is thus taken as the zero-point: indeed, it is the only possible zero that exists for our adoption, just as in describing the height or depth of a tide we take the mean sea-level (which is nearly but not quite constant) as our datum and measure from that, instead of trying to start from low-water-mark (which is exceedingly variable) or the highest recorded flood-line (which may easily be exceeded). Accordingly, a child's individual deviation from the general average can be expressed as so many times the 'standard' deviation; and a plus or a minus sign will be affixed to show whether he is above or below this central level.

This device, as I have insisted in an earlier publication,[1] is by far the most scientific for all purposes of mental measurement. In fact, with older and brighter children, as we shall see in a moment, this (or its equivalent in some convertible unit) is the only form of measurement that is really practicable.

(iii) *Rating Scales.*—Marks or measurements expressed in terms of standard deviations or percentiles are somewhat recondite and cumbersome for everyday use. With most mental qualities it is hardly possible to discriminate as many as 100 different grades; 5 to 15 steps are usually the utmost that the ordinary person can distinguish. Hence many examiners prefer to use a limited scale of marks—*e.g.* five letters, A, B, C, D, E, or five numbers—and loosely define them as representing simple differences of quality—'very good,' 'good,' 'average,' 'poor,' 'very poor.' Verbal definitions of this kind, however, are interpreted very differently by different individuals; and the principle underlying percentiles and standard deviations would enable us to define these simpler marks far more accurately on the basis of an order of merit. Thus A may be defined as 'a quality so much above the average as to be obtained by the top 5 per cent. of a random group'—*i.e.* the first to the fifth percentile; B as 'a quality somewhat above the average, such as would be obtained by the next 25 per cent. of the group'; C as 'average quality such as would be

[1] *L.C.C. Report, loc. cit.*, pp. 31 *et seq.*

obtained by the middle 40 per cent. of the group'; D as 'quality somewhat below average such as would be obtained by the next 25 per cent.'; E as 'quality very much below average such as would be obtained by the bottom 5 per cent.'

These percentages, it may be observed, approximately define the grades in units of a single standard deviation.[1] Pluses and minuses can be added after the letters if finer shades of distinction are desired, 'C +' being a little better than plain 'C,' and 'C —' a little poorer. When it is necessary to total or average the marks, the letters can easily be converted into a numerical scale. The value of such rating scales will most readily be seen when we come to assess the qualitative characteristics of individual children—those of temperament, for instance, or of character.

I have experimented with scales thus standardized, not only in internal and external examinations at school—for example, the marking of composition either by teachers or by scholarship examiners, but also in various University examinations for certificates, diplomas, and degrees; and I find that these statistical definitions of the marks nearly always render the results sent in by different examiners far

[1] There are five grades; and a range of five times the standard deviation —*i.e.* from — 2·5 S.D. to + 2·5 S.D.—includes practically all the individuals in a small random group of about a hundred. With what is called normal distribution, only 0·62 per cent. of a group would fall beyond ± 2·5 S.D. (*i.e.* two and a half times the standard deviation below or above the average). The figures given in the text are approximate only: for each successive S.D. unit the actual percentages would be nearer 6·7, 24·2, 38·3, 24·2, 6·7 per cent. respectively. A simple way to estimate the normal proportions for a given number of grades is to expand the binomial $(1 + 1)^{n-1}$, where n is the number of grades. Thus for the five grades, A, B, C, D, and E, the number obtaining each mark should be proportionate to 1 : 4 : 6 : 4 : 1; for fifteen grades, A +, A, A —, B + . . . etc., proportionate to the expansion of $(1 + 1)^{14}$. The scaling of marks in terms of the standard deviation I have illustrated and advocated in the L.C.C. Report already cited, p. 50.

In assigning an impressionistic mark to essays, compositions, drawings, specimens of handwriting, examination scripts, and the like, it will generally be found that the best plan is to sort the productions of the several candidates into the requisite number of piles (those deserving the marks of A, B, C, D, and E, for example), eventually readjusting the piles so that there is approximately the correct proportion in each one. It is simplest to begin

more just and comparable. The analysis of marks at University examinations is perhaps the most instructive, since here the examiners are men and women of long experience, and tradition has built up a fairly well-recognized set of standards for the different classes. Most University examiners who use numerical marks apparently take 50 (or a little more) out of 100 as the average mark, and somewhere between 30 and 40 per cent. as the border-line for a failure. Calculations based on typical mark-lists show that in practice the standard deviation is about 10 marks or rather less. This yields the following distribution, which is now in actual use in certain degree and certificate examinations ; it is, of course, only one of several possible scales.

TABLE I. STANDARD SCALE OF MARKING

Marks in Letters .	A+	A	A−	B+	B	B−	C+	C	C−	D+	D	D−	E
Marks in Figures . (Maximum 100)	80	75	70	65	60	55	50	45	40	35	30	25	20
Suggested distribution (per cent. of candidates) .	0·2	1	2·8	6·5	12	17·5	20	17·5	12	6·5	2·8	1	0·2

Examiners who use literal marks generally treat A as roughly indicating First Class or Distinction, B Second Class, C

by dividing the scripts or papers into three main sets—above average, average, and below average, and then to subdivide these sets into finer groupings if desired. A comparative experiment, in which both methods are tried with the same batch of candidates, will readily demonstrate that this procedure gives far more reliable and accurate results than the commoner procedure of going through the scripts or papers in the order in which they are received and trying to allot an absolute mark to each as it comes. With the procedure I have advocated, the examiner is forced to compare specimens of work that are close to one another in general merit. A similar plan may be adopted with advantage when making assessments for temperamental qualities. Here it will often be found helpful to have a photograph of every child to be assessed. For each quality to be rated, photographs are then dealt out into piles as before. Where the assessors are thoroughly familiar with the children, it may be sufficient to have the children's names written each on a separate card instead of using photographs. Actual trial will show that this procedure leads to a far more rigorous and effective comparison. The application of these methods of rating to temperamental qualities I have briefly illustrated by concrete cases in *The Measurement of Mental Capacities* p. 29.

Third Class, D Doubtful—probable Failure, E irredeemable Failure. As a result, not C but C + here corresponds to an average mark of 50. This perhaps is partly owing to the fact that examiners wish to err, if anything, on the generous side, and so allot plain C to those who are in fact a little below the average. For any given examination, the above distribution, given in percentage of candidates, would require to be readjusted according to the average proportion of failures and first classes actually obtained during preceding years.[1]

In the near future some such scale will doubtless become almost universal in all important academic examinations; and I believe every teacher would find it a great convenience if it were adopted as part of the regular technique in ordinary school marking.

Nevertheless, as the student unversed in statistics will be the first to admit, these definitions and calculations are somewhat laborious; and results couched in such terms are not immediately intelligible to the plain and practical man. With many mental characteristics, however, particularly those that steadily progress from year to year and can be directly tested—intelligence, for example, or attainments in the chief subjects of the elementary curriculum —there is another set of mental units, simpler to assess and far easier to understand, units which will be quite sufficient for the everyday purposes of the teacher in dealing with young or backward individuals. These units are termed the mental age, the mental ratio, and the mental retardation. I term them psychological units rather than statistical units, since they rest on a psychological theory of development, namely, that the annual increments of mental growth are at every stage approximately equal.

[1] It will be observed that the effective range is from 20 to 80. This is because, in averaging marks for different papers and questions for the same candidate, the range automatically tends to get reduced. If a first-rate candidate receives 90 or 100 per cent. (*i.e.* usually 9 or 10 marks out of 10) for his best question, he will probably only get 85 per cent. or less for his best paper; and this, when averaged with his poorer papers, will bring his final mark down below 80 per cent. This reduction is often forgotten by inexperienced examiners, who tend to mark isolated questions or papers on too restricted a range.

2. Psychological Units

(i) *Mental Age.*—Since intellectual subnormality may be regarded as an arrest or retardation of the normal rate of growth, it follows that one convenient unit for measuring the backward child will be the mental or educational year. In that way we state explicitly what level of growth the individual child has reached. Thus, intelligence, and its degree of development, are expressed in terms of a *mental* age ; and similarly the notion of an *educational* age can be used to mark the point to which the child has attained in his school progress.

The principle of an age-scale was first systematically applied by Binet. He adopted it, to begin with, to measure mental defect. It was, however, by no means an entirely novel idea. The Revised Code, issued by the Board of Education in 1862, was founded upon an analogous conception. It stipulated that every scholar, for whom grants might be claimed, should be examined according to one of six 'standards' (to which a seventh was soon afterwards added). The 'standard' was to depend upon the age of the child, and it was set forth in detail for the various ages and school subjects.

One effect of this regulation was inevitable. Nearly all the elementary schools in England were at once organized upon a basis of annual promotion. Each class in the senior department corresponded to a scholastic year ; and the whole series of classes were ultimately numbered and named Standards I to VII. A child coming up from the infants' school at the age of 7 was placed in Standard I ; next year, at the age of 8, he was moved to Standard II ; and so on, year by year.

During the past thirty years this mode of organization has been greatly changed, and in many schools and areas is now disappearing. Teachers have strenuously opposed the scheme. But their objections were levelled, not so much against the Board's method of testing, as against its principle of 'payment by results.' The opinion of almost all educationists is now averse from anything like a periodical examination conducted solely by an external body to test

the efficiency of school instruction or to standardize and even up the general results. The standards, or rather the norms, introduced by the psychologist have a totally different object ; they seek to specify, not an ideal level to which all children *should* attain, but the actual level to which the average child *does* in point of fact attain.

The standards of the Board as first formulated had many flaws : and, obvious as these defects now seem in the light of recent work, they are not entirely uninstructive. They arose from the way in which the Board's requirements were reached. Its prescriptions were derived, not from any experimental inquiry into what children of a stated age actually know, but from *a priori* notions of what they ought to know. Consequently, the detailed formulations for the several ages were neither precise nor wholly appropriate ; and the wide range of individual capacity was altogether ignored.[1]

Many teachers still think in terms of these old requirements, and are able to say in what standard a particular pupil is or should be working. This yields a rough notion of the child's educational level, which employers and medical officers have come to understand. In asking about 'standards,' however, the inquirer, whether employer, medical officer, psychologist, or social visitor, should frame his queries with some care : it will not be sufficient to ask the teacher 'what class the child is in,' since the classes may not correspond to standards ; and, even where they do correspond, an older child may still be placed in Standard VI or VII solely on the ground of age. The question to be put, therefore, is : what standard is the child's work equal to ?

[1] A conspicuous instance was the demand that 'the child should be able to spell words from the same books as he uses for reading.' Experimental surveys demonstrate quite clearly that, with rare exceptions, to spell a given word is harder than to recognize it when spelt already in print. Most teachers can read the word 'psychology,' but not all of them can write it. A child, as a rule, can read the longer words of his everyday speaking vocabulary nearly twelve or eighteen months before he can spell them. Indeed, almost all the requirements first put forward by the Board proved to be too hard in their general level, by the equivalent of about one year ; and, later on, what was originally prescribed for Standard I was transferred to Standard II, and similarly throughout the series.

But for the sake of greater precision and to facilitate comparison with other measurements, it will evidently be better to express the child's attainments, not in terms of the so-called standards, but in terms of a mental or educational age, especially as mental ages are now regularly used for assessing intelligence. The following equation is often handy:

$$\text{Standard} = \text{Age} - 6.$$

Thus a boy whose work is described as Standard IV should have approximately the educational level of a normal child of $(4 + 6) = 10$.[1]

In adopting the notion of an age-scale for the measurement of intelligence, Binet at first suggested that the various grades of mental deficiency might be defined in terms of mental years. Thus he described idiots as persons with an intelligence below the mental age of 2, imbeciles as those with a mental level between the ages of 2 and 5, and the feebleminded as those with a mental level between the ages of 5 and 9.[2] These general limits still serve for

[1] To determine the approximate mean age of a given standard, and the approximate mean standard for a given age, the more precise regression-equations are as follows:

$$\text{Age} = \cdot 96 \times \text{Standard} + 6\cdot 4 \text{ Years.}$$
$$\text{Standard} = \cdot 93 \times \text{Age} - 5\cdot 6 \text{ Years.}$$

The two equations differ a little; the difference arises from the fact that the correlation between age and standard is not perfect. On an average, children advance, not by a whole standard, but by about $\frac{19}{20}$ of a standard for each successive year. Thus, of children aged 13, only the brighter half reach the level of the top class, namely, Standard VII. Cf. L.C.C. *Report*, p. 24. And for a general discussion of 'Age as a Unit of Mental Measurement,' see *Mental and Scholastic Tests*, Appendix IV, pp. 439 *et seq*.

[2] Binet and Simon, *The Development of Intelligence in Children* (translated by E. Kite, 1916, p. 166; cf. also p. 267). The various pronouncements are not always consistent. In later publications both the French writers and their American followers were disposed to raise the borderlines, and then, more recently still, to lower them again. Thus, in one of the last articles in the volume just quoted (*loc. cit.*, p. 270) Binet and Simon gave the upper limit for imbecility as 7 years. About the upper limit for feeblemindedness they are still more vague: in his address to the Eugenics Society, Simon 'provisionally proposes the age of 9' (*Eugenics Review*, VI, 1915, 'The Measurement of Intelligence,' p. 304). Endorsing a scheme put forward by Goddard, the American Association for the Study of the Feebleminded tentatively fixed the upper level of feeblemindedness at a mental age of 12

adults.[1] But they could hardly be applied to the very young. A boy of 6 with a mental age of 6 would not be feebleminded, although below the level just stated; he would be a perfectly normal person.

(ii) *Mental Retardation.*—Accordingly, Binet later proposed to consider, not the absolute mental age of the child in question, but its relation to the child's physical age by the calendar, and to measure the degree of defect by the difference between the two. His suggestion may be put in the form of an equation:

$$\text{Mental Retardation} = \text{Chronological Age} - \text{Mental Age}.$$

A boy of 10 who has a mental age of 7 is thus said to be retarded by $(10 - 7) = 3$ mental years. On this basis Binet declared that any child who was backward by three years or more should be recognized as mentally deficient.

The change, however, still does not wholly dispose of the complications that arise from disparities in chronological age. Clearly a backwardness of three years at the age of 5 is far more serious than a backwardness of three years at the age of 15. At the age of 50 a backwardness of three years would be almost indiscernible; while at the age of 2 no

(*Report of Lincoln Meeting*, 1910). The application of intelligence tests to recruits for the American army during the first world war produced rather startling results. It appeared that, if the standardization of the Stanford-Binet scale could be trusted, and if the recruits could be accepted as constituting a fair sample, the average mental age of the American population was only 13·1 years, and over 40 per cent. had a mental age of 12 or less (Yoakum and Yerkes, *Army Mental Tests*).

[1] Before the passing of the 1944 Act, the borderlines in general use were those of the *Report of the Joint Committee on Mental Deficiency* (H.M. Stationery Office, 1929). The upper limits there proposed were (i) idiots, a mental age of 2½ to 3 (mental ratio, 20); (ii) imbeciles, a mental age of 5½ to 6 (mental ratio, 40); (iii) feebleminded, a mental age of 8 (mental ratio, 60) for the fully adult, and one of 9 rising gradually to 10 (mental ratio rising to 70) for those whose chronological age ranges from 21 down to 16. (The reasons for this transitional borderline will appear presently: see below, p. 33.) But for all persons over school age the ultimate diagnosis must depend primarily upon their general capacity for social adaptation, and not solely upon their mere intelligence as measured by mental age and intellectual tests (cf. *Report*, Pt. iv, pp. 41–6).

child could be backward by three years. In fact, tests applied to the same children at successive periods of their school life prove that, not only is there more room for retardation as the child grows older, but that actually *the amount of a given child's mental retardation almost invariably increases with increasing age, and usually in direct proportion.*[1]

(iii) *Mental Ratio.*—It has, therefore, been proposed to measure the child's mental level, no longer by the difference between his mental and chronological age, but by their proportion or ratio; instead of the mental age being subtracted from the chronological age, it is to be divided by the chronological age. The result is generally written as a percentage, and termed the mental ratio or 'intelligence quotient' (I.Q.): thus

$$\text{Mental Ratio} = \frac{\text{Mental Age}}{\text{Chronological Age}} \times 100.$$

The peculiar value of the formula arises from one interesting and well-established fact—a rider to the conclusion cited above. The repetition of the tests with almost any group of children year after year throughout the period of growth shows that almost every individual tends to maintain very much the same relation between his mental and his

[1] See, for example, the diagrams given by Burt in *Distribution of Educational Abilities*, 1917, p. 31, fig. 5, and later reports, where the S.D.'s (σ) for each age are plotted against chronological age (A) itself: in all these graphs the ratio σ/A is approximately constant; and the best-fitting straight line is one having a gradient of $k = \text{av}\sigma / \text{av}A$ and intersecting the base-line at or near the point Age (A) = O. Evidently, then, if D represents the deviation for a given child at age C, kD will be his expected deviation at age kA; and, during school years, the ratio $(kD + kA)/kA = R$ remains approximately constant. It was this result that led me to suggest the 'Mental Ratio' (100 R) as a convenient measure independent of change in age. Nevertheless, as the graphs show, the ratio σ/A, though approximately constant, fluctuates appreciably about the line thus fitted, usually increasing towards age 7, and again towards puberty before finally declining. Various ingenious devices have been suggested to correct for these fluctuations in the I.Q. (cf. *e.g.* J. F. Roberts and M. A. Mellone, 'Adjustment of Terman-Merrill I.Q.'s to Secure Comparability at Different Ages,' *Brit. J. Stat. Psychol.*, V, pp. 65–72). However, as I have argued elsewhere (*loc. cit.*, pp. 48 f.), the safest procedure is to use a 'conventional I.Q.,' calculated not from the formula in the text, but from the percentile score taking S.D. = 15 points (see below, p. 36).

chronological ages. Hence, *during school years the mental ratio is approximately constant.*[1]

This approximate uniformity has now been demonstrated by a formidable array of investigations. An important corollary follows. The constancy of the ratio must confer a useful power of prediction. Having measured a child's rate of development for the first few years of his life, we can foretell, with a fair degree of assurance, both his subsequent course of progress and his ultimate intellectual limit. A boy is brought to the psychologist at the age of 5. The psychologist tests him; and finds that his mental age is only 2. The child, therefore, is backward by three years ($5 - 2 = 3$); and his mental ratio is 40 per cent. ($\frac{2}{5} \times 100 = 40$). Should the psychologist then venture on a forecast, he can calculate, on these assumptions, what will be the child's probable level at any later date. At the age of 10, for example, his mental age will be 40 per cent. of 10, that is 4. At the age of 15 his mental age will be 40 per cent. of 15, that is 6. Now, it has further been shown by experimental testing that *at the age of about fifteen the growth of innate intelligence comes virtually to a final halt*; so we may treat the child's mental age at that date as marking the furthest limit of his growth, and as signalizing his destined level to the end of his adult days. A youth, therefore, with a mental ratio of 40, will, when grown up, have the intelligence of a child of 6, and no more. He will be permanently deficient, and a fit case for an institution.[2]

In theory, all this can be foreshadowed, with a reasonable chance of fulfilment, at the early age of 5. In practice, of course, the psychologist would probably keep his anticipations to himself, and use them only as a private guide for his

[1] *Mental and Scholastic Tests*, pp. 152 *et seq.* The idea of a 'mental ratio' was independently suggested by W. Stern, but on purely *a priori* grounds. His phrase 'intelligence quotient' (I.Q.) has usually been adopted in America, and has thus come into regular use.

[2] The dull generally come to a virtual arrest a little before 15, and the mentally deficient still earlier. Hence the *Report on Mental Deficiency* suggests taking a denominator of 14, rather than 15, in the case of defective adults. However, after the age of 15 it is better to use either a ratio based on percentiles or else the mental age. But for scientific purposes the I.Q. is quite unsuitable.

provisional proposals. It would be rash for anyone—and highly impolitic for a teacher untrained in psychological diagnosis—to utter such prognostications after applying his tests but once: mental ages below 3 or 4 are difficult to determine, and the testing of any child under 6 is somewhat precarious. But after these early stages, as experience amply shows, such prophecies are borne out by the child's later development in nineteen cases out of twenty.

Educational Age and Educational Ratio.—For measuring a pupil's educational level, units can be employed similar to those devised for measuring his intellectual level. We have seen that, for each of the subjects of the elementary curriculum, standards may be drawn up representing the average or normal attainment at each successive year. Thus, a given individual's performances in a series of scholastic tests may each of them be expressed in terms of a mental age—an age for reading, an age for spelling, an age for arithmetic, and so forth. The average of the mental ages obtained for the separate subjects may be termed the child's educational age. As before, however, we must take into account the chronological age of the particular pupil. If we divide his educational age by his chronological age, and express the fraction as a percentage, we arrive at a figure which, I have suggested, may be conveniently called the child's educational ratio.[1]

Achievement Ratio.—Perhaps the most relevant comparison of all turns on the relation between the child's school attainments and his inborn intellectual capacity, that is, between his educational age as obtained by the scholastic tests and his mental age as obtained by the tests of intelligence. This is popularly though not very accurately expressed by a ratio which has been named the child's 'achievement ratio' or 'accomplishment ratio.' Its calculation is shown by the following equation:

$$\text{Achievement Ratio} = \frac{\text{Educational Age}}{\text{Mental Age}} \times 100.$$

If a child's achievement ratio is exactly 100, then teaching is keeping pace with mental growth; the child, it may be

[1] See *L.C.C. Report*, *loc. cit. sup.*, p. 15.

inferred, is learning his lessons up to the full limit of his inborn capacity.

Achievement ratios over 100 are sometimes met with among the dull. At first sight this may seem something of a paradox; and the examiner may begin to question the accuracy of his tests. How, he will ask, can a child possibly show achievements which are greater than his ability? Is this not the conjuror's trick of pouring more than a quart of wine out of a quart bottle? The explanation is that a child's achievements in school depend on many different factors. His general intelligence, which alone is considered in assessing his mental age, is only one of them, though generally the most important. The efficiency of the teaching, the interest and industry of the child, particularly under ordinary methods of instruction, his special aptitudes, and above all his powers of memory, play at times a very considerable part. Thus, if the child's powers of sheer mechanical memorization are greater than his general intelligence, an achievement ratio of 110 or even 120 is by no means an impossibility; and, provided the testing can be trusted, figures like these should lead the examiner to suspect some such special influence. These high ratios, however, are comparatively rare. They occur sporadically in a few young bookworms who show an extra zeal or talent in academic work, but less practical shrewdness and little common sense. They occur, rather more frequently, in dull youngsters who have been assiduously coached by a good teacher, and have thus been laboriously brought on, till their acquirements in the more mechanical subjects rise above what other pupils of their own meagre powers would ordinarily reach.

In nearly all other cases, *the dull, and most of all the defective, prove far more behindhand in school attainments than they are in mental development.* I find that the achievement ratio of the dull children I have tested amounts, on an average, to 91; while that of the feebleminded amounts to 87 before admission to a special school, and to 93 afterwards. Now, if a child's achievement ratio drops much below 100, that is a signal for something to be done. Some external cause—ill-health or irregular attendance,

laziness on the part of the child or unsuitable methods on the part of the teacher—is probably to blame. Under normal conditions, the teacher may gauge his own efficiency, as well as the child's, upon much the same principle—that is, by his success in keeping the achievement-ratio of all his pupils close to 100 per cent.[1]

The foregoing, then, are the various numerical devices that are available both for measuring mental capacity and development and for assessing educational progress and attainments. All, it will be seen, essentially rest on the use of standardized tests. Accordingly, the practical teacher will now desire to know something of the technique involved in the actual testing, and what special kinds of test he may safely select.

[1] Several writers, unfamiliar with the earlier literature of the subject, have declared that 'recent research has entirely disproved the old claim that the I.Q. of the individual child is constant': 'it may even change 30 to 40 points, . . . and many children with I.Q.'s in the 50 to 70 range may show themselves capable of coping with education in the ordinary school' (cf. *Secondary School Selection*, 1957, pp. 104–6, and references). This is distinctly misleading. The utmost that was claimed was that, under appropriate conditions, the I.Q. remains *approximately* constant; and, in one of the earliest discussions of the subject (*Mental and Scholastic Tests*, 1921, pp. 152 *et seq.*), many instances were given in which it had appreciably changed. If, however, a child's I.Q. were to change by as much as 40 points, that would mean that at 10 (say) he had a mental age of 8, while at 12 it rose to 14. A change of this kind could only occur if the tests used were inappropriate, or badly administered, or based (as was often the case in the researches quoted) on American tests like the Wechsler which have not been properly standardized for English children. It is equally misleading to suppose that the inconstancy is due solely to the unreliability of the tests: it arises chiefly from the fluctuations in the S.D. noted above (see p. 32 and refs.).

My references to the 'educational ratio' have since been criticized by several writers (cf. *Education*, ÇVIII, No. 2811, p. 868 and refs., and later issues). But, more than once here and in the reports just cited, I emphasized that 'measurements in terms of a ratio are quite unsuitable for purposes of research': to compare a child's actual attainments with his potential ability it is much better to take the *differences between standard measures* than to take the *ratios between the corresponding mental ages*. Ratios were suggested instead of the more accurate technical procedures solely for purposes of popular exposition and the rough practical uses of the teacher in the classroom.

CHAPTER III

THE DISCOVERY AND INVESTIGATION OF BACKWARD CASES

(B) *The Choice of Tests*

The Types of Tests in General Use.—Tests may be classified according to their purpose, their general procedure, and the material they employ.[1]

(i) As regards their *purpose*, the tests chiefly used with school children may be grouped under two main heads—psychological and pedagogical, or, as they are sometimes termed, mental and scholastic. The object of psychological tests is to measure, so far as possible, the child's innate mental capacities; the aim of scholastic tests is to measure, as accurately as can be, the knowledge which the child possesses of the various subjects of the curriculum. The former are tests of endowment; the latter, tests of acquirement. The former estimate the mental capital which was the child's legacy at birth; the latter the annual income which has since accrued to him in virtue of a wise investment of his talents and a steady application to his work.

It will be remarked that the words ' mental ' and ' psychological ' are here taken in a somewhat narrow sense. From

[1] On the general value of scientific tests in the educational system, the reader may refer, not only to the popular books of Dr. Ballard cited below, but also to the Board of Education's *Report on Psychological Tests of Educable Capacity*, with its detailed bibliography (H.M. Stationery Office, 1924). Psychological investigators usually limit themselves to determining merely the ' reliability ' and 'validity ' of each test. What the educational administrator wants to know is whether the *additional* information so provided will justify the probable *cost*. Teachers who undertake researches on these problems therefore should adapt the usual formulae to these requirements, instead of merely calculating coefficients of correlation. The theory of ' expectation ' in gambling and economics indicates the principles involved.

a wider standpoint any test of knowledge, whether invented by the psychologist or carried out as part of the school routine, is strictly a psychological exercise. The examiner who marks scholarship papers, and the teacher who sets questions on the work of the past term, are both psychologizing: both are essaying some kind of mental measurement. And if ordinary scholastic examinations are to aspire to any degree of scientific exactitude, they must be founded upon the same technical principles as have been worked out for mental tests and for psychological examinations in general.

(ii) As regards *procedure*, all tests, whether psychological or pedagogical, may again be divided into two main forms —(*a*) oral or 'individual' tests, (*b*) written or 'group' tests. To the teacher the distinction between an oral and a written examination, as carried out for school or academic purposes, is a commonplace; the psychologist prefers to contrast what he calls 'individual' and 'group' testing respectively. In practice the two distinctions tend to coincide; and the new terms are mainly employed to discriminate the two alternative methods that can be adopted in testing intelligence.

(*a*) In oral tests both questions and answers are given by word of mouth; they proceed by the method of repartee. Since the psychologist's tests are all standardized beforehand, it follows that identical questions must be set to every child; and, consequently, each child must be examined singly and privately in a personal interview. Hence, in psychological examinations, an oral test is nearly always an individual test. The well-known Binet-Simon scale, for example, is composed almost exclusively of tests carried out by an oral and individual procedure.

(*b*) Group tests are tests that can be applied to a number of children simultaneously, sitting together in class. Usually, therefore, group tests are also written tests. The general arrangement is much the same as that which is observed in ordinary school examinations. Roneo'd sheets or printed booklets, containing the questions to be worked, are handed round to the pupils; and the pupils write or

mark their answers, either in the spaces provided, or against appropriate numbers on separate slips of paper.

(iii) As regards *material*, tests may be once more cross-classified into two distinct kinds—(*a*) verbal and (*b*) non-verbal.

(*a*) Both oral tests and written tests are almost inevitably verbal. The questions are put in words; and the examinee is expected to reply in words. The result, therefore, must turn in part upon the verbal facility of the child. In testing sheer intelligence this is at times a serious drawback. With tests like those drawn up by Binet and Simon, it is often the ready tongue that scores: the glib, plausible, sociable girl sometimes seems brighter than she really is; while the boy, far less accustomed to the interchange of conversation, may stand shy, sheepish, and mute, and so fail altogether. Yet, after all, for assessments of intelligence it is not what the child says, but what he can do, that should count; and of recent years, psychologists have tried to devise some mode of testing in which the questions should be put to the child in the guise of more concrete and practical tasks—something that he can see or do.

(*b*) In the commonest of the non-verbal tests, therefore, the problem is set in visual and usually in pictorial form, and the solution consists, not in an oral response, but rather in some ingenious manipulation of the material placed before the child. Such tests have earned the nickname of 'performance tests,' though strictly no test could test anything else. The simplest and the most effective are rather like jigsaw puzzles: they consist of pictures cut up into pieces which the child has to re-arrange, assembling the several parts to construct an intelligible whole. In others the child has to fit pegs into holes, cubes into a box, insets into corresponding hollows, to build up a tower of graduated blocks, to trace out the pathway through a printed maze, or to open a puzzle-box by a set of interlocking levers.

Of necessity, most performance tests are individual tests. To supply all the children in the class with special apparatus, and to time each one as he performs the necessary actions, would hardly be a practicable plan. Of late, however, experiments have been made in adapting non-verbal material

to the group procedure by using a booklet of pictures or figures, which the children have to mark, alter, or complete with their pencils, according to instructions called out by the teacher. Since the emphasis is now more on what the child can see than on what he can do, such tests may be called ‘ perceptual ’ rather than ‘ performance ’ tests.

Whether verbal or non-verbal, individual or group, mental or scholastic, all such tests must be carefully standardized beforehand. First, the test itself is tested to ensure that it really measures the capacity intended ; and then, when a number of satisfactory problems have been assembled and the worthless discarded from the list, the whole is tried out with hundreds of boys and girls at every age of school life to obtain ‘ norms ’ of actual performance —that is, means or averages for each successive year, and standard deviations showing the normal or average degree of variability above or below the mean.

Which of these various test-methods is the teacher to borrow ? The choice must turn mainly on the mental age and on the past experience of the child. For wide preliminary surveys, group tests are the most convenient, if only because they demand less time. On the other hand, for testing young or defective children—those below Standard II or a mental age of about 9—individual tests are almost indispensable. Further, wherever there is a need for psychological diagnosis, wherever the fate of the child may hang upon the issue, the test should always be individual : a group test is too easily disturbed by irrelevant influences that pass unnoticed in a crowd. The individual test brings the examiner into personal contact with the child. It allows him to glean impressions, as well as to mark results. It permits him to watch at close quarters the young mind's method of working, and to detect where it is weak. It leaves him free to follow up whatever clue the child's mistakes or reticences may yield, and to help out the standardized routine (which by rule must be the same for every one) with a change of manner, with the insertion of a new task, or with the addition of some supplementary question—all expressly adapted to meet the peculiar needs of each individual case. In the old-fashioned examination

the *viva voce* interview was a mere casual appendage to the written papers. In the new technique of psychological assessment the written tests serve merely to pick out the special cases, and leave it to the oral test to clinch and analyse the results, and to lay bare the underlying causes.

For rough and rapid purposes verbal material is at once the readiest and most useful. But the findings require frequently to be checked by tests of a non-verbal type. Unfortunately the performance tests, so attractive at first sight, prove the least reliable of all. The best we have at present are little more than semi-scientific puzzles, and, like all puzzles, depend for their solution almost as much upon luck as upon genuine insight into the problem. Hence a large number of different problems must be set, before we can safely trust the total result. The procedure takes time, and the apparatus costs money. Nevertheless, where the child to be examined is deaf, or unfamiliar with the language, where he has failed to enjoy an ordinary home training or has missed the opportunities of an ordinary school life, above all where he is too bashful, too inarticulate, too flurried and confused to show his real powers in a short conversational interview, there, at least as an accessory, some test of a practical type should be applied. Nothing puts the nervous child so quickly at his ease as giving him something to do with his hands; and for this special purpose the performance test forms an invaluable stand-by.

Suitable Tests for Backward Children.—Whether the procedure adopted be the group method or the individual method, I recommend that, with the pupil who is going regularly to school, the examiner should always start with tests of scholastic attainments, turning later, if necessity demands, to psychological tests of intelligence. With the pre-school child, or with children who for some reason or other have lately been away from their school, most of all with adolescents and adults, it is better to invert the order. In any wide survey of a whole school or of a whole district, educational tests must usually be relied upon in the first instance, since here the primary object is to discover those who are backward educationally, whether or no their

intelligence is subnormal: moreover, the children who are backward in intelligence must, almost inevitably, be backward in school work, and will betray their weakness there. On the other hand, in examining single pupils, a reasonable success in a test of school knowledge may be enough to dispel, without more ado, any suspicion that the child's intelligence may be defective: for the examiner, as a rule, may safely argue that, without a normal intelligence, the child never could have learnt what he manifestly knows. Nevertheless, a scholastic test, like a group test, can only give a helpful lead, and must always leave a wide margin for exact interpretation. In every case of backwardness an individual test of intelligence will ultimately prove essential.

The teacher, however, who undertakes mental testing for the first time, generally presses for more detailed information, and would like to be told specifically which of the numerous ready-made test-scales are most fitted for his use. Here only provisional advice can be given. New sets of tests are continually being placed on the market, each aiming to improve upon the old; and, further, as soon as an effective test has become well-known, there is a danger that it may already be familiar to the child, or even have been exploited by a teacher or a parent as a convenient point of departure for actual instruction.

(1) *Scholastic Tests: (a) Group Tests.*—In group surveys of older children, where educational attainments are primarily to be measured, a set of printed booklets containing well-tried problems, like the Northumberland Standardized Tests (1925 Series), will be generally found the best to begin with. From the customary examination paper such booklets differ in two or three ways.

In the first place, the tests are composed, not of half a dozen long sums and one or two topics for an essay, but of numerous little problems—perhaps as many as two or three hundred. It is a plan that strikes most teachers as bizarre. Yet a prolonged series of investigations has conclusively proved its value. No psychologist now doubts that, for the purposes of general testing, and granted the same time-limits, *it is far more effective to use a large number of short questions than a small number of long questions.* Chance has

smaller play; choice has less weight; and the different branches of the subject can be more exhaustively explored. It is the principle of the machine-gun pitted against the fourteen-pounder: the slow heavy shot may carry farther, but may miss its mark completely; the quick little bullets cover the ground more widely and more speedily, and it is harder to get through their hail. One disadvantage, however, this plan undoubtedly entails. Unless some other device is also included, the child has little scope to display any power of sustained consecutive thought, or of original and constructive imagination. Such powers, however, are hardly to be looked for in the backward or the dull; and with these, at any rate, but little is lost.

There is a second peculiarity about these booklets. Instead of writing essays at full length, instead of copying long sums on to a separate sheet and then working through them in detail, all the child has to do is to discover and mark the correct answers in the booklet itself. The questions are usually set out with alternative replies inserted; for example:

$$\text{(i) Henry VIII was the } \left\{\begin{array}{l}\text{son}\\ \text{father}\\ \text{nephew}\end{array}\right\} \text{ of } \left\{\begin{array}{l}\text{Henry Tudor.}\\ \text{Edward IV.}\\ \text{Edward VI.}\end{array}\right.$$

$$\text{(ii) Negroes are } \left\{\begin{array}{l}\text{white}\\ \text{black}\\ \text{yellow}\end{array}\right\} \text{ people who live in } \left\{\begin{array}{l}\text{China}\\ \text{Iceland}\\ \text{Africa}\end{array}\right.$$

$$\text{where it is very } \left\{\begin{array}{l}\text{hot.}\\ \text{cold.}\\ \text{snowy.}\end{array}\right.$$

The child is told to cross out the wrong answers or (more usually) to underline the right. This at once eliminates any difference due to speed of writing—a factor that is wholly irrelevant and gains a disproportionate weight when the young examinee has barely learnt to manage the pen. Further, the child has simply to choose between the answers given, instead of inventing answers of his own. That aids the examiner as much as the child. It makes the marking easy, quick, and unequivocal. After all, until he has tried to frame his own reply, is an examiner always

sure of the true answers to his questions ? And, when every child can phrase his answer as he likes, will all the examiners agree which answer is the best ? In the new method, to avoid doubts and discrepancies of this kind, the possible replies are limited to the two or three stated alternatives printed in the child's question-paper, and the right replies are decided beforehand and set down in the examiner's key. In this way, the marking is rendered so mechanical that it can be done by a conscientious clerk or a careful child in the top standard.

Finally—and this is perhaps the most valuable asset of all—the questions themselves, as we have seen, have all been punctiliously tried out and selected by a long, elaborate process of experimental testing ; and, on the basis of the results, standards of achievement have been compiled. No longer has the examiner to trust to his own judgment in determining which performances are up to average merit, which are superior, and which are below par and by how much. All is indicated by a table accompanying the key.

Throughout, therefore, it will be seen, the tests aim at being fool-proof ; and a fool-proof test, as a famous examiner has said, is one that prevents the examiner from making a fool of himself, while leaving the examinee perfect freedom to do so. In point of fact, the devices I have just described were worked out first for group tests of intelligence. Teachers and education authorities, however, will find that the same principles greatly increase the efficiency and speed of tests for school attainments ; and a similar plan might well be adopted in the internal tests set by the school and in the examinations for free places set by the local authority. That they should wholly supersede the old-fashioned methods I do not suggest : but they would, I am convinced, prove a valuable supplement and corrective.

The Northumberland Standardized Series may be taken as an illustrative instance. In this there are three booklets. The first comprises tests of arithmetic : it contains graduated exercises in the four fundamental processes —addition, subtraction, multiplication, and division ; another set, similarly graduated, for all the main rules ; a series

of problems in reasoning, and a series in mental arithmetic. The second booklet is designed as a test of English: it contains exercises in reading in its various forms—reading words, sentences, questions, and paragraphs—exercises in spelling and dictation, problems in geography and history, and a few incidental exercises in grammar and composition. The third booklet provides a test of general intelligence, to be used in conjunction with the tests of school attainments. With the booklets a manual of instructions is supplied, describing the method of setting the tests and of marking the results. It includes a key giving the right answers, notes on typical mistakes, and a table of norms giving average performances for normal boys and girls from the age of 7 to the age of 14.

The booklets have been so arranged as to enable the teacher to discover not only the dull and the backward, but also, at the same time, the brighter and the better informed, and those fit for scholarships to secondary schools.[1] They are suitable for use with older children only, from about Standard III upwards. In constructing group tests for children below that level, special difficulties are encountered: children so young have hardly acquired the requisite facility in reading and writing.

Even with older children, the use of printed booklets is not without certain drawbacks. When one clean booklet, fresh from the publisher, is needed by every child that is tested, and can never be employed again, the price begins to mount up, and an extensive examination is bound to prove costly. Further, when the questions set have already been published, there is always the risk that some enterprising teacher may have previously bought a copy, and have tried it on his pupils. Hence, where any vital issue is at stake, there is much to be said in favour of head

[1] It was, indeed, for this double purpose that this series was first devised at the request of the Education Authority for the County of Northumberland; and I am particularly indebted to that authority for permission to reprint and publish the tests in a revised and generally accessible form. They are to be obtained from the University of London Press: Specimen set—comprising Test I (Arithmetic), Test II (English), Test III (General Intelligence), with Manual of Instructions and Answers.

teachers and education authorities constructing new tests of their own.[1]

The value of standardized tests for assessing educational attainments is now pretty generally realized. I need only quote the report of a joint advisory committee, which included representatives of the National Union of Teachers as well as of the Association of Education Committees; the committee rightly argues that 'if more use were made of standard tests by teachers for their own school purposes, including diagnostic purposes, greater reliance could be placed on the teacher's opinion and on the record of the child's progress.'[2] And the report goes on to endorse the opinion of an authoritative witness, who strongly urged that 'instruction in the use of standard tests should be an integral part of the college curriculum.'

I must add, however, that the regular or periodical use of such standardized tests by an external authority, particularly if the object is to test the efficiency of the school, is to be strongly deprecated. Of necessity, nearly all such tests measure primarily the more mechanical elements of the elementary curriculum; and, if taken as a criterion of teaching efficiency, would rapidly lead to the neglect of the subtler and more elusive essentials of a liberal education.

For a broad preliminary review, I find that a couple of scholastic tests alone are usually sufficient to detect those who are backward educationally. The two tests that together yield the most effective results are a test of spelling and a test of mental arithmetic. For spelling I recommend

[1] The interested teacher will often find it possible to compile his own by culling from the available literature such questions and such tests as seem fitted to his particular type of school. For this purpose the two popular little books by Dr. P. B. Ballard, called *Group Tests of Intelligence* and *The New Examiner* (University of London Press, 1922 and 1923 respectively), will be found invaluable: not only do they contain suggestive specimen tests; they provide a clear, detailed, and entertaining exposition of the new methods for all who wish to understand them. The *Mental Measurements Yearbooks*, edited by O. K. Buros (Highland Park, New Jersey), give admirable reviews of publications on psychological and educational tests.

[2] *Examinations in Public Elementary Schools: Report of an Inquiry undertaken by the Joint Advisory Committee of the A.E.C. and the N.U.T.* (Schoolmaster Publishing Company, 1930), p. 93.

some form of graded vocabulary test; for arithmetic, a graded test in mental work, consisting of two problems for each successive year.[1] As a rule, the teacher need use only the test-words and the sums appropriate to the lower ages; he can arrange for the children to write what is wanted on slips of paper instead of replying by word of mouth. In a group test for juniors, this simple twofold combination will be all that is generally required. So rough a test, however, must be followed by a personal examination of the special cases thus singled out; and every branch of the curriculum will then be tried and tested in turn.

(*b*) *Individual Tests.*—For the individual testing of scholastic attainments—more particularly with cases of backwardness or alleged mental deficiency—I venture to suggest the detailed series drawn up with the assistance of teachers in London, and printed in an earlier L.C.C. Report.[2] Imperfect as such scales no doubt may be, they still remain, I believe, the only comprehensive system of school tests, all framed on a comparable basis, as yet available for use in this country.[3] The test-problems have been standardized by experimental application to more than 5,000 normal children and 1,500 mental defectives in London. The majority are arranged in the form of a graded age-scale: each scale contains ten words that can just be read, ten words that can just be spelt, ten sums that can just be answered, by 50

[1] Both these tests were designed primarily as individual tests, but they prove to be unexpectedly efficient for class testing also. With the latter procedure the norms are but slightly changed. In testing brighter children I should substitute for the spelling test a test of the comprehension of reading: but that cannot be so readily employed in a group examination of the dull or backward.

[2] *Mental and Scholastic Tests* (first published as *L.C.C. Report, No.* 2052; Staples Press, 1947). Two or three of my test-scales from this Report, together with many useful tests of his own, will be found incorporated in another book by my friend and colleague, Dr. Ballard, entitled *Mental Tests* (University of London Press). For the teacher who finds himself bewildered by the elaborate statistical discussions which crowd the pages of more technical works, there could be no better or more popular introduction to the subject than this instructive little volume.

[3] The test-materials have been reprinted in a cheap and handy form by the Council's publisher, under the title of *Handbook of Tests for Use in Schools* (Staples Press, 1948).

per cent. of normal boys and girls at each successive year. In the space of a very few minutes it is thus possible to assign to any particular child a mental age for each of the main subjects of the elementary curriculum.

For what may be termed qualitative subjects, like handwriting, drawing, and English composition, the method of median specimens may most conveniently be used.[1] The larger L.C.C. Report contains typical productions for every year of school life, selected by a careful statistical procedure as representative of average children at each stage. The whole series forms a standard scale of reference. To assess handwriting, for example, the teacher asks the child to write all the capital letters of the alphabet, and then a short sentence containing all the small letters (*e.g.* 'pack my box with five dozen liquor jugs'). The specimen so obtained he compares with the facsimiles given in the book: after a little preliminary practice, he will find it easy to allot a child a mental age for handwriting on the basis of such a comparison. For drawing, the child is asked to 'draw a man'; for English composition, to 'write an essay on "School"': similar comparisons can then be made with the specimen drawings and the specimen essays reproduced as typical samples for each age.

Once more, for speedy work the tests can be reduced in number. Where the medical officer has to examine a dozen suspected children in the course of a single session, two tests will usually be adequate for all but the borderline

[1] If children, or their productions, are arranged in order of merit, then the middle specimen is called the median. As we have seen (p. 23 above), it represents the 50th percentile, *i.e.* that central measurement above which (and therefore below which) 50 per cent. of the individuals lie. If the curve of distribution is symmetrical, the median coincides with the average. Rank a class of children according to their height, and measure the mid-most: it will then be found that his measurement approximates very closely to the average as computed by the more ordinary, more precise, and more cumbersome method—namely, measuring each child, adding up the total, and dividing by the number in the group. The method of median samples, therefore, affords a speedy means of arriving at the average, when time or other considerations make the full procedure impracticable. I strongly recommend this device whenever it is desired to make a rough preliminary standardization of attainments in some new area or in some new test, and where a prolonged research is out of the question.

cases, namely, the vocabulary test of reading, and a few problems from the test for mental arithmetic, if these have not been used before (a couple of problems from two or three successive ages are, as a rule, quite sufficient). The reading test takes about two minutes, and the arithmetic test about four or five. The child's educational level can thus be closely estimated in about six minutes. To gain some notion of the child's manual and practical abilities, a drawing test, like the one just described, affords a useful supplement. This can be carried out, without further loss of time, while the parent is being interviewed or another child examined.

If in these two or three tests the child's performances are fairly consistent, and rise well above the borderline, the examination need not be prolonged. A child who comes fully up to the requisite standard in reading, writing, and drawing is not likely to be below that level in innate intelligence. But if his performances hover on or near the margin, then more searching tests of school attainments, or of native ability, or of both will be indispensable. With a backward reader, for example, it may prove essential to investigate, not merely his reading-vocabulary with a list of isolated words, but also his comprehension of connected print, his ability to read a story with ease, fluency, and suitable expression, and his power to seize the meaning of what he reads. For this purpose additional tests have been drawn up, and adapted for children of different levels. For the child who is backward in some other branch—in spelling, writing, or arithmetic, the tests must be extended in other directions. But, all through, the examiner saves time, energy, and a number of perplexing doubts, by having a condensed scale of testing-material ready to his hand, instead of being obliged to improvise questions on the spot, and then start wondering how a normal child would probably answer. In this way, by relying on standardized methods, and by referring to a standardized scale, it is possible to examine a child in all the main school subjects, and to give him a mental age for each one, in the course of a brief personal interview that should last but little more than three-quarters of an hour.

(2) *Psychological Tests: (A) General Intelligence.*—That a particular child is found lacking in scholastic knowledge or attainments does not of itself yield proof that he is dull or defective in native ability as well. The teacher is a little too apt to draw this conclusion, basing his inferences solely on the traditional type of school examination or his own casual impressions in the classroom. He may easily be misled. Acquirements form a doubtful measure of capacity, and ignorance is no guarantee of dullness. Some further evidence is wanted. After applying the scholastic tests, and in order to elucidate their findings, we must turn to the so-called psychological tests.

A test of intelligence should always be applied. Even where nothing is known of the child's past history, the measurement of his innate intelligence may at once disclose whether his lack of progress is due to an inherent inferiority in power to learn, or whether, since his ability is perfectly normal, some extraneous cause has been at work—ill-health, irregular attendance, or inefficient teaching. If the test demonstrates that the backward child is also innately dull, the teacher may at least reap the comforting assurance that his own teaching-methods are not entirely to blame; he will also feel cautioned not to press the child beyond his powers, much less to upbraid him for laziness or inattention.

Wherever, therefore, the scholastic tests show that a particular child is behind the level for his age in his educational attainments, the next step is to determine the child's intelligence. But personally I should go further. I would strongly urge that every child entering a new department—whether he comes to that department from outside or has simply been transferred from the infants'—should, as a matter of school routine, be subjected to a test of intelligence as well as examined in his scholastic attainments, and that he should be allocated to his new class on the joint results of both. After all, it is what a child can learn, not what he has learnt, that should count; and the golden maxim should be this: *promote by attainment rather than by age, and by ability rather than by attainment.* Too often the order of preference is inverted; and the child is either pushed up because of his age and size, or else kept down

because his spelling is atrocious and he cannot work the rule of three. Always, in assigning a child to his appropriate class, the main deciding factor should be the child's innate capacity.[1]

(*a*) *Group Tests.*—(i) *Verbal.*—For testing intelligence a wide variety of group tests is now at the service of teachers. The principles generally adopted may be seen from a glance at the booklet of intelligence tests which I have already mentioned as forming part of the Northumberland Standardized Tests (1925 Series). Here the problems are based upon the theory that the best criterion of intelligence is the child's power to perceive logical relations—relations such as those of similarity, of difference, of contrast (the relation obtaining between opposites), of cause and effect, of evidence or implication (the relation expressed by such conjunctions as 'since' and 'therefore'), of relevance or fitness, and the like. Indeed, all the higher intellectual processes may be summed up, so Professor Spearman has declared, in two simple formulæ—the eduction of relations and the eduction of correlates.[2] Both are exemplified in a test which I have called (after a phrase in Aristotle) the analogies test. It consists of a kind of 'rule of three' problem in words: for example,

Black *is to* White *as* Bad *is to* . . . ?

In such a test the child has first to educe the relation between 'Black' and 'White.' Here it is clearly a relation of contrast: the two words are opposites. He has then to apply this relation to the word 'Bad' and educe the corresponding correlate—namely, 'Good.' Test-problems of

[1] It is by no means easy to determine with any particular test or population, how far the differences in test-results are attributable to innate capacity or to environmental influences. In my view the most effective method is what I call 'the factorial analysis of variance.' This is based on Fisher's proposal to analyse intra-class correlations for relatives into the variance 'between' and 'within families' respectively (*Statistical Methods for Research Workers*, 1934, pp. 212f.). It can readily be extended to cover variance due to genetic and environmental conditions respectively: see below, p. 675.

[2] This view was first put forward in my article on 'Experimental Tests of Higher Mental Processes,' *J. Exp. Ped.*, I, 1911, pp. 101f. Spearman originally identified intelligence with sensory discrimination.

this kind, it is discovered,[1] are exceedingly reliable and give high correlations with intelligence itself.

When tests of intelligence were first introduced, psychologists were highly sceptical of anything like a class examination for this purpose; teachers and others often feel the same doubts about group testing. In the early days of intelligence testing, however, the tests which the psychologist employed were concernedprincipally with elementary functions—sensation, perception, or movement, sometimes combined into a single sensori-motor process. In a series of researches carried out before the war, I endeavoured to show that, as criteria of general intelligence, tests of higher mental processes were far superior to tests of the lower and simpler mental functions; and at the same time I pointed out that tests of the former type lent themselves readily to a group procedure: indeed, with these newer tests the group procedure is often more effective than the individual. It was found that what is commonly called the reliability coefficient [2] of such a test rose from about ·6 or ·7—the usual figure obtained with an individual procedure —to nearly ·9 with the group procedure. Certainly, with young and backward children the individual test must always remain the more satisfactory; but with older or brighter children—particularly those who, with the approach of puberty, are acquiring something of the self-consciousness of the young adolescent—a class test arouses far less embarrassment and emotional confusion than an oral test or a *viva voce* examination.[3]

During the war, group testing of intelligence was carried out by American psychologists on an extensive scale; and the success attending their efforts has led to the introduction of a large assortment of group tests for general purposes. Of the American group tests the Terman and the Otis

[1] See Burt, 'Experimental Tests of Higher Mental Processes and their Relation to General Intelligence,' *Journal of Experimental Pedagogy*, 1911, I, ii, pp. 100 *et seq.*

[2] The reliability coefficient is a measure of the self-consistency of a test: it indicates how far the results of two successive applications of the same test agree or correlate with each other. Complete agreement is expressed by unity (1·00); complete absence of agreement by 0.

[3] *Loc. cit.*, p. 106.

(' Advanced Examination ') give better results than the National, though this last—no doubt from its use during and after the 1914–1918 war—seems better known. Of English tests the earlier Northumberland Mental Tests, devised by Professor Godfrey Thomson, are in many ways the most ingenious and original; but the later Moray House tests, also constructed by Professor Thomson, are in the view of their author more reliable.[1] Mr. Richardson's Simplex Test embodies some of the best devices of earlier group tests, and has, in my experience, given excellent results. The third booklet of the Northumberland (1925) Series has the advantage of being comparable with the educational booklets in the same series. Different tests, however, have different merits; and hence it is impossible to arrange them in a single order of preference. One of my own research-students, Mr. J. H. Wilson, has undertaken an experimental

[1] Most of the American tests are obtainable from the World Book Company, Chicago; their English agents are Messrs. G. G. Harrap & Company, who publish the Otis, Terman, and National (American) tests, and Richardson's Simplex and Junior Simplex Tests. The Moray House tests are compiled primarily for education authorities, and are not available for general purchase in the ordinary way. Directors of Education, and institutions desiring to make use of such tests, can obtain particulars from the Education Department, University of London Press.

It is, however, seldom advisable to rely solely on verbal tests. Many group tests of a non-verbal type have recently become available which can be usefully employed to supplement tests of the older type. Since the previous edition of this book was published, a popular non-verbal test in group form has been issued, under the title of ' Progressive Matrices.' This is a graded version of the test described below as ' serial analogies.' As may be seen from the scheme on p. 56, the principle is essentially that of a ' matrix ' of rank one, expressed through spatial rather than numerical relations. Its present form is due to Mr. J. C. Raven, who developed it at University College: for details see his M.A. thesis and later publications. For younger children the Moray House Picture Test is among the best.

A *Supplementary Memorandum*, issued by the Board of Education (July 1936, Pamphlet No. 63), recommends that a test of intelligence ' be included in every examination for the award of special places ' (p. 7). For scholarship examinations, however, and for all official surveys, it is desirable that the tests should be constructed, not by an enlightened amateur, but by an expert who has had a proper training in psychological technique and who will spend the necessary time and labour on checking and standardizing the test before it is put to its final use.

comparison of the more popular sets. A detailed discussion will be found in his article on 'A Comparison of Intelligence Scales.'[1]

Nearly all the foregoing tests, however, are rather hard for backward children at the earlier years. For younger children, Dr. Ballard's *Group Test for Juniors*[2] will be found suggestive. Mr. Richardson, too, has just issued a new Junior Simplex test which has been standardized on the school population of Blackburn, 12,000 boys and girls, including every age from 6 to 14.[3] For those, however, who are too young or too backward to read, write and spell, material of a non-verbal type is almost inevitable if the group procedure is to be used.

(ii) *Non-Verbal.*—Group tests with non-verbal material are still in an experimental stage. The usual procedure is to present the problem by means of pictures or little diagrams, set out in printed booklets and supplemented if necessary by an oral explanation from the teacher with an example perhaps worked on the blackboard. The child is required to indicate his answer in the same fashion, not by writing words, but pictorially or diagrammatically—usually by drawing one or two simple lines. For example, he sees pictures that are obviously unfinished—a face without an eye, a clock without a minute hand, and so on; and has to complete each sketch. He sees patterns of increasing intricacy—a circle, a square, a diamond, a star made of two superposed triangles; and has to copy each pattern. He sees a series of objects—an apple, a banana, and various

[1] *Brit. Journ. Psychol.*, XV, i, 1925, pp. 44 *et seq.*

[2] *The New Examiner*, pp. 236 and 245. The advantage of this test is that the teacher dictates the questions, and writes the necessary words on the blackboard; hence the cost of a printed booklet for each child is saved. This expedient is trustworthy only when the same examiner sets the test and the children are all at much the same distance from the board. It is thus a very inexpensive way of testing one small class; but I should hesitate to recommend it where the classes are large and, still more, where the test has to be conducted by different examiners. Further research is needed with tests along these lines, to see how far it is possible to eliminate each examiner's 'personal equation.'

[3] Cf. C. A. Richardson and C. W. Stocks, 'The Growth and Variability of Intelligence,' *Brit. Journ. Psychol., Monograph Supplements*, 1934, No. XVIII.

other well-known kinds of fruit, and among them a book ; and has to cross through the one which does not belong to the same group as the rest. Of the American booklets, perhaps the most satisfactory are those known as the Otis Group Intelligence Tests, Primary Examination Form.[1] Comparatively few tests of this type have been constructed or used in this country. Quite recently, however, one of my own research-students, Dr. G. F. Sleight, has compiled a Non-Verbal Group Test along these lines, specially for use with backward children in England.[2]

A number of systematic researches are in progress at the Psychological Laboratory, University College, which are endeavouring to determine the general principles that should be followed in constructing group tests of a non-verbal form. The results have shown that exceedingly satisfactory tests of intelligence can be obtained by taking the types of problem used for the ordinary verbal group tests and adapting them for use with perceptual material. Thus, instead of arranging words or figures in a series, the child is required to arrange shapes or colours in a series, *e.g.* to arrange a number of greys in order of increasing darkness ; or, again, he is required to mark shapes that are similar or those that are different, or to show by a few simple lines how a figure of definite shape and size may be built up out of a number of triangles or rectangles already drawn. As before, the most important principle is to devise a problem that calls for logical thinking—that is, the perception of relations and the eduction of correlates. Thus it is not difficult to invent an analogy test (a ' rule of

[1] Two forms are published, Form A and Form B. Devised as they were for American children, the details of the tests in their original shape are not always quite appropriate for children in this country. With the permission, however, of the English publisher, and after experimenting with the original test-questions, with a view to their use in the ascertainment of mentally defective cases in a rapid survey of large areas, Dr. Lewis (Medical Officer of the Board of Control) and I have modified and combined Dr. Otis's two alternative versions. A copy of the revised and anglicized arrangement will be found in the pocket at the end of the *Report of the Mental Deficiency Committee* (H.M. Stationery Office, 1929, Part IV, pp. 226 *et seq.*). The tests and the directions can be obtained from Messrs. G. G. Harrap & Co.

[2] Also published by Harrap & Co., 1931.

three ' test) embodying the problem, not in words, but in shapes or colours : *e.g.* ' this small triangle is to that large triangle as that small square is to . . . ? ' the appropriate large square having to be selected from three or four alternative shapes drawn on the paper. If, instead of two pairs of two terms only, what I have called ' serial analogies ' are used, almost any degree of complexity may be achieved. The general principle of construction may be represented symbolically as follows :

$$
\begin{array}{lcccccccc}
 & a_{11}\, b_{11} & : & a_{12}\, b_{21} & : & \cdots & : & a_{1m}\, b_{m1} \\
:: & a_{21}\, b_{12} & : & a_{22}\, b_{22} & : & \cdots & : & a_{2m}\, b_{m2} \\
 & \cdots & : & \cdots & : & \cdots & : & \cdots \\
:: & a_{n1}\, b_{1n} & : & a_{nn}\, b_{2n} & : & \cdots & : & x \ ?
\end{array}
$$

where a_{ij} and b_{ji} denote essential aspects of the test-material—shape, colour, line, position, or the like—changing systematically step by step. With small geometrical figures as a basis, an infinite variety of problems, lending themselves admirably to grading and standardization, can thus be compiled.

(*b*) *Individual Tests.*—(i) *Verbal.*—By means of a group test alone, however, no final diagnosis can be made either of dullness or deficiency. Such tests are of use in this connexion, as indeed I have already implied, only to catch in their wide-flung meshes the more suspicious cases, so that a closer first-hand scrutiny may be made of each one later on. Every backward child, and every instance of suspected mental defect, whether discovered by group tests or by everyday observation in the classroom, should always be examined, singly and separately, by some more intensive personal test. In selecting candidates for scholarships, there is no doubt that, on the whole, a group method, as embodied in the ordinary written examination, is more efficient than an ordinary oral interview, unsupplemented by any written work. But with the dull, the defective, and the very young, the case is reversed ; with them, provided a standardized technique is used, the oral method is much more trustworthy and exact.

Among individual tests of intelligence the Binet-Simon Scale is by far the simplest and the most convenient, as it is

by far the most widely known. There are many different versions. The least valuable are those in which the age-assignments are left in their original French or American form. A test that is passed by children in Paris or California at one age may be passed by London children at quite a different age. Binet, for example, in his 1908 scale, did not expect the normal child to name the four primary colours until the age of 8 : in London nearly every normal child can name them by the age of 5—a discrepancy of three years. In his 1911 scale Binet placed the test of repeating seven numbers at the age of 15 ; Terman, in his American revision, lowered it to 14 ; London children can manage it before they are 12. Differences such as these are often disregarded by the teacher or school medical officer : he assumes that the scale is of universal applicability even in its earliest shape.

Re-standardization is essential wherever the wording of the questions has to be modified. Those who use the Stanford Revision sometimes fail to note that Terman's translation is usually more appropriate to American children than to English. Take one of the questions put to children of six : 'What's the thing to do if you are going some place and miss your car ? ' ; or again, one of the problems put to children of 8 : 'What's the thing for you to do when you notice on your way to school you are in danger of being tardy ? ' Such phrasing may be quite unintelligible to English pupils of these ages. Nor is it sufficient for the teacher to amend the mode of expression, and take it for granted that the difficulty and age-level of the test will be left unchanged. Terman himself insists that 'the form of the question must not under any circumstances be altered.' The coins, of course, cannot possibly remain the same ; but when English coins are substituted for American, the introduction of our florin and half-crown renders the problems far more perplexing. Even where the phraseology and the test-materials are alike satisfactory, the American age-assignments cannot be taken over as they stand : for English children of the ages specified, the scholastic problems are a little too easy, and the practical problems a little too hard. It must, therefore, be emphasized that, whatever

version be followed in setting the questions, the age-assignments adopted in evaluating the replies ought always to be standardized beforehand on British children, and, if possible, upon children in the locality where the scale is to be used.[1]

(ii) *Non-Verbal ('Performance') Tests.*—The most complete account of performance tests is to be found in Pintner and Paterson's book upon the subject.[2] The series there described, or rather a slightly modified collection, has been re-standardized on London children by Miss Frances Gaw. Full instructions, with norms, will be found in her pamph-

[1] Although it seems essential to readapt the age-assignments, I am against any tampering with the test-questions themselves. They are far from perfect; but, if every investigator makes his own revision, all possibility of comparison is lost, and improvised modifications are more likely to impair than to improve the validity of the tests.

Andrew Lang, whose English translations are the envy of every undergraduate, was once caught by a witty friend with a Greek text on his desk: 'I see you are reading Homer's *Iliad*,' observed the visitor drily: 'I believe it is still the best'! Binet has been retranslated and re-edited almost as often as Homer; but it is my private conviction that Binet's own version of the Binet tests should still be regarded as the most authentic.

Adhering so far as possible to their original form, we have in London carefully standardized the tests by experiments upon over 3,000 children; the re-arrangement is published in the *L.C.C. Report on Mental and Scholastic Tests*. A practical compendium, together with the necessary materials, is reprinted in the little *Handbook* already referred to. For older and brighter children, the *Stanford Revision and Extension* (Harrap & Co., 1916) is certainly superior to the French collection. It inserts, at these later levels, a number of new, ingenious, though somewhat lengthy problems (for detailed instructions see Terman's *Measurement of Intelligence*, *ibid.*, 1916). For younger and defective children, however, the particular tests used differ very little in Terman's arrangement and in my own earlier revision: both of us have independently found that Binet's original age-assignments were here a little too easy. Hence the results here obtained by either version are not very discrepant at this level.

With Professor Terman's own consent, and with the assistance of my colleagues and students, I have standardized an English adaptation of this American extension. The modified instructions have not yet been printed, but are in use in many child-guidance clinics. The main differences, however, appear in the allocation of the several ages. The allocation that seems most suitable for English children will be found in my book on *The Subnormal Mind*, pp. 348–51.

[2] Pintner, R. and Paterson, D., *A Scale of Performance Tests* (Appleton & Co., 1917).

let.[1] Where time is strictly limited, the best single test of this type is the series of graded mazes devised by Dr. Porteus for testing dull and defective children.[2]

The value of these non-verbal tests for gauging the intelligence of children brought up under exceptional conditions is excellently demonstrated by a recent research carried out among canal-boat children. Eighty of these boys and girls were examined with the Binet-Simon Scale by Mr. Hugh Gordon, one of His Majesty's inspectors of schools. Their average mental ratio proved to be 69, that is, just below the borderline accepted for the mentally defective. Could these tests have been taken as a trustworthy indication of the children's intelligence, more than half would have been marked down as feebleminded. The same boys and girls were then tested by Miss Gaw, who used her series of performance tests. With these, the average mental ratio rose as high as 82 ; and barely one child in ten appeared to be feebleminded.[3] The reason for the

[1] Frances Gaw, *Performance Tests of Intelligence* (Reports of the Medical Research Council: Industrial Fatigue Research Board, No. 31, H.M. Stationery Office, 1925). F. M. Earle's more recent investigation of the problem will be found instructive : *The Use of Performance Tests of Intelligence* (*ibid.*).

[2] The series will be found printed in my *Handbook of Tests*. For younger children a test which always appeals is the block-design test of Kohs (see his *Intelligence Measurement*, Macmillan Co., 1923). In Scotland Dr. Drever and Dr. Mary Collins have compiled a valuable series of performance tests, which, among other advantages, have the merit of being specially adaptable for use with the deaf (*Performance Tests of Intelligence*, Oliver and Boyd). For use among foreign children my own students have found great value in Stewart Dodd's perceptual tests of intelligence: these consist of familiar tests, like Analogies, Similarities, Differences, and the like, with small geometrical figures. The apparatus and instructions are to be obtained from the Stores Department of Princeton University. Though somewhat cumbrous for that purpose, they can also be employed as group tests. Similar tests have been devised at University College, and compiled into convenient booklets: after further standardization they will no doubt be available for general use.

[3] Board of Education: Educational Pamphlets, No. 44, *Mental and Scholastic Tests among Retarded Children*, 1923, pp. 33–45. Frances Gaw, 'A Study of Performance Tests,' *Brit. Journ. of Psychol.*, 1925, XV, p. 390. (Owing to the perpetual travelling of the families, the group tested by Miss Gaw, I gather, did not include the whole of the group tested by Mr. Gordon : but in the Binet tests the mental ratio of her sample was precisely the same as that of Mr. Gordon's larger group.)

discrepancy is plain. Spending most of their lives upon the waterways, attending school for only a few months in the year, and during the rest of the time cut off from all social intercourse with their fellows, these canal-boat children have grown up under very abnormal conditions; the simple worldly store of information—the ideas, the words, the conversational ease and facility, spontaneously picked up by most other children, and presupposed by the Binet-Simon tests, were all deplorably lacking in this peculiar little batch. Naturally in verbal tests they failed. But when, instead of answering commonplace problems by word of mouth, they were required to look at things and to manipulate things, their true capacities had some chance to display themselves.

Performance tests, therefore, are particularly useful for those exceptional children who are handicapped in some special way for the ordinary tests of the Binet-Simon type—the deaf, the stuttering, and those who, from illness, truancy, or other cause, have missed even the common minimum of everyday instruction which the Binet-Simon Scale can safely assume in the general run of school-pupils. Above all, as I have already pointed out, they are especially appropriate with the taciturn, the nervous, and the shy.

But they yield another advantage. Because the child is asked to express himself by actual movement, and, as it were, to do his thinking with his hands, these tests are particularly suited to reveal the way he tackles his task. With performance tests, as, indeed, with tests of every type, the most illuminating information is to be sought, not in the final figure which grades the child's performance—his mark, his mental age, or his speed in minutes and seconds—but rather in his general mode of setting about the problem. The observant teacher, and the psychologist who has gained his experience by using the same standardized tests time after time, will quickly catch, as they watch the child at work, vivid glimpses into his capacity and temperament. His ability to plan ahead, his systematic or unsystematic method of attacking situations, his impulsiveness or prudence, his carelessness or caution, his powers of perseverance, of profiting by his own mistakes, of criticizing

his first attempts, all this is suggestively brought out by tests of the performance type. Always, indeed, attention to such incidental points will afford a penetrating insight into the individual child, and will be infinitely more instructive than any numerical measure.

(2) *Psychological Tests: (B) Special Abilities.*—Psychological tests are by no means restricted to the measurement of innate intelligence. We have seen that efficiency in every form of work, whether in school or in after-life, depends upon intellectual factors of two kinds: it is determined not only by the individual's general intelligence, but also by his special aptitudes. To do well in arithmetic, for example, a boy must have not only a high measure of intelligence, but also a specialized ability for perceiving numerical relations. Similarly, as we shall find, a child may fail in arithmetic for one of two reasons: either because his intelligence is subnormal, or else because, with an intelligence quite equal to the average, he possesses some peculiar, localized defect which prevents him from understanding or manipulating figures. And the same applies to failure in all the other subjects of the school curriculum.

In theory, therefore, to make a complete study of any backward child, we ought to test not only his general intelligence but also his more specific intellectual or cognitive capacities. The examination of sight and hearing should be undertaken in every case. Generally this is regarded as the business of the school doctor. But in itself it is, like all measurements of sensory acuity, strictly speaking, a special form of psychological testing, and involves a well-recognized scientific technique. For the more complex cognitive processes—visual perception (' observation '), auditory perception, speed and accuracy of hand-movement, memory in its different forms, attention, reasoning, imagination, and the like—various tests have been devised.[1] But unfortunately psychologists themselves are still undecided

[1] The best collection of standardized tests is that contained in Whipple's *Manual of Mental and Physical Tests* (two volumes; Warwick & York, Baltimore, 1914, 20*s*.). As its title page announces, this is a ' book of directions, compiled with special reference to the experimental study of school children in the laboratory or classroom.'

as to which intellectual aptitudes and disabilities are really specific and which depend mainly on general intelligence. Moreover, to test and measure these more specialized processes nearly always demands the equipment of a laboratory; and statistical calculations of some complexity are usually essential to eliminate the influence of intelligence itself. At child guidance clinics and psychological institutions such methods are resorted to from time to time for special cases—most frequently for those who are normal in general intelligence, but seem incapable of making progress in one particular school subject. But the technique, the apparatus, and the computations required, are hardly within the reach of the ordinary teacher. If he has had no training in laboratory methods, but nevertheless has had considerable practical experience in dealing with children of various types, the teacher, as a rule, will best discover what is at fault by watching the child in his actual work with the subject that occasions most difficulty—a procedure, indeed, that might be adopted more freely by the psychologist himself.

Observational Methods.—I am thus led to emphasize the value of observation generally, both as a regular preliminary and as an indispensable adjunct to all other means of study.

Psychology, like every branch of science, may avail itself of two main methods of investigation: the method of experiment and the method of observation. Its recent advances have been due almost entirely to the former—the method of experiment. It is to that method that we owe the valuable conception of mental tests. Yet, in spite of the progress made in this and other directions, I am convinced that the second method—the method of observation—though neglected in recent years, will prove equally rich and fruitful. It is a mode of approach which the individual psychologist has of late been too prone to despise. Psychology is a biological science; and in other departments of biology—for example, in botany and natural history—the foundations of knowledge were laid by means of systematic observation—inspecting plants and their structure, noting the appearances of different animals, their habits, distribution, and various ways of living. In building up a science

of the human mind the same procedure should be exploited to its utmost. For the psychologist who desires to watch the mind at work under simple and controllable conditions, and above all to trace its gradual development, there could be no better field of observation than the schoolroom. In particular, we need to collect and compare (and who could do it so methodically as the schoolmaster and the school medical officer, had they only the requisite time?) case-studies of typical and a-typical children; and for this purpose what may be called a clinical approach is far more productive than the limited devices of experimental testing. A mental test is only the beginning, never the end, of the study of the individual child.

There is one sphere, indeed, in which the experimental method has remained disappointingly sterile, and for practical needs all but useless. Where the problem is one of temperament or character rather than of knowledge or intelligence, we are confined almost exclusively, in our search for positive evidence, to methods of observation: in such a case, carefully compiled records, first-hand notes of the child's actual behaviour, and a review of his natural reactions to the natural situations of everyday life—these will be of far more value than any psychological test.

Supplementary Lines of Investigation.—The psychologist, therefore, and the psychologizing teacher, must observe as well as test. Indeed, with every backward child, it is imperative to explore many other fields of inquiry besides that which is immediately covered by the psychological examination itself. Teachers, magistrates, and social workers, seem at times to credit the examining officer with an uncanny power of penetration. By means of technical tests, or of a practised eye for hidden symptoms, he is expected to discover the fundamental trouble with no other assistance but a brief half-hour in his consulting-room with the child himself. He is supposed to detect deficiency with the same directness and speed as a physician would recognize a full-blown case of small-pox. To furnish him with a detailed report of the child's past history, to supply him with a statement of the home conditions and the child's behaviour in the world outside, to allow time for him to see the

parents or the child's teacher, all this is often thought to be superfluous; or rather, never thought of at all. Nor can psychologists themselves be entirely absolved from blame: in the past, as their published papers show, they have too often been content to descend on a reformatory or rescue-home, put every inmate through their scale of tests, and then return with the pronouncement that 70 or 80 per cent. of the institution were mentally defective.[1]

Rarely should a diagnosis be attempted by a psychologist or school medical officer solely on the basis of what he himself has been able to elicit. It is impossible to prescribe proper treatment for a backward case without first discovering the causes; and it is impossible to discover causes without exploring all the circumstances, physical, social, and scholastic, past as well as present, which may have affected the child's mental development. Every field of evidence must be reviewed.

What additional sources, then, are available? The various directions in which further evidence may be sought fall under half a dozen separate and familiar heads; and, in the case-review, each of these should be kept distinct.

(1) *Physical Examination.*—In addition to the psychological examination, there should first of all be a physical examination. Every case of backwardness or suspected mental deficiency should be thoroughly overhauled in body as well as in mind. In our search for causes we need to discover, not only the set-back the child's progress may have received through accident, disease, or mal-development, but also any innate or constitutional weakness that may have hampered him from the very outset of his life. This in turn will demand a review of the child's physical history in the past, and a thorough inspection of his bodily condition at present, together with some assessment of the rate and regularity of his growth. The physical examination will thus include a double survey—a medical examination proper, concerned chiefly with bodily deformities and defects of

[1] See, for the more glaring instances, the summary of earlier American investigations brought together by Wallin, *Problems of Subnormality*, pp. 123 *et seq.*

health, and an anthropometric examination, concerned chiefly with measurements of the child's physique.[1]

(*a*) *Medical.*—The medical examination will largely follow the routine lines that are now well recognized, though more time will be spent with each child. Special attention must be paid to defects or diseases that may tend to lower his vitality, to disturb the working of his nervous system, or to impair the efficiency of the sensory and muscular apparatus upon which all practical work whether in the school or elsewhere must inevitably depend—his sight, his hearing, his speech, and his power of manual co-ordination. The details I shall discuss in considering the physical causes of backwardness.

Here I may venture to add one tentative suggestion : it would be particularly helpful in these cases, if the results of the inspection were not recorded in unintelligible and often illegible hieroglyphics and kept locked up in a card-index drawer. Admittedly the information is highly confidential ; yet I see no reason why all that has been discovered about the child's physical condition should not be made accessible, with the sanction of the child's parent if necessary, for the enlightenment of the teacher and of any authorized person who has to deal at first hand with the individual case. Should such a suggestion be followed, teachers must first learn in their training courses something of the bearing of bodily conditions upon mental capacity, and will need to be as discreet as a physician or a priest in respecting the privacy of whatever knowledge is placed at their disposal.[2]

(*b*) *Anthropometric.*—Besides studying ailments and abnormalities, due to unnatural causes, it is equally desirable that the child's natural course of growth—or what appears to be its natural course—should be noted, measured, and

[1] It will, in fact, in many respects approximate to that employed by experienced school medical officers in dealing with a case of suspected mental deficiency. The procedure is admirably described in Shrubsall and Williams's volume on *Mental Deficiency Practice* (University of London Press, 1932). Fuller details of the methods suitable for practical use in school are given in James Kerr's *Fundamentals of School Health* (Allen & Unwin, 1926).

[2] Cases in which teachers have thoughtlessly referred to a child's ailments, either in speaking about him to his parents or openly in front of the class,

recorded from time to time. The value of such measurements lies in this : it is often far more instructive to compare a child's mental development with his bodily development, instead of with his mere chronological age as marked by the calendar. For example, if a child is growing so slowly that, in height, weight, and general proportions, he is two or three years behind the average, we might also expect him to fall behind the average in the development of intellect and character ; and, if he does, we should be led to inquire whether this may really be the result of some underlying pathological condition, as in the case of the cretin, or whether it is merely due to some natural delay in normal growth which may perhaps be compensated for at a later stage. With older children towards the time of puberty the degree of physiological maturity is of special importance.

It is essential that all these different aspects of the child's general development should be investigated, as well as his development in purely mental characteristics. In order to compare different results it will be convenient if the measurements are expressed in analogous terms, namely, with the year or annual increment as the unit. The terms physical age, anatomical age, and physiological age, are all in use, sometimes with, sometimes without, a slight difference of meaning. It would perhaps be helpful to reserve ' physical age ' for degree of growth as estimated by simple physical measurements, such as height and weight ; ' anatomical age ' for degree of development as determined by changes in the structure of the body, for example, by the emergence of teeth or the ossification of bones ; and ' physiological age ' for degree of maturity as determined by bodily functions, for example, menstruation and other

are rare enough. Nevertheless, in a large area, difficulties of this sort are sufficiently frequent to make most school medical officers chary of handing on medical information about the children they have examined. If the practice I have suggested could become general, the medical officer would, in the long run, be assisted by the teacher, as much as the teacher would be assisted by the medical officer ; for the teacher would become more efficient in directing the medical officer's attention to cases or to symptoms that might otherwise escape notice during a rapid inspection, and would be able to report more accurately on the child's physical progress.

processes that ripen towards puberty. Certainly, each of these points should be inquired into with each individual case. But, as we shall find later on, the various assessments prove to be positively intercorrelated, and in most children the underlying features measured seem closely interdependent: indeed, in any particular boy or girl, any sign of anomalous or inharmonious development would itself be of supreme importance.

While the measurements and observations are actually being made, note should incidentally be taken of the child's constitutional type, if it is at all distinctive, and of so-called stigmata of degeneracy, if any are present. The former is sometimes suggestive in considering the child's emotional temperament; the latter in considering the possibility of mental deficiency.

(2) *Home Circumstances.*—The psychologist, however, cannot restrict his survey to what he himself directly observes. He must rely also on the observations of others. He should have before him all that is known about the child's previous development and about his life beyond the school walls. This means that others must be trained to observe scientifically—the care committee visitor, the social worker, and the visiting nurse—and that reports, couched, not in the chatty style of an entertaining letter, but in exact language methodically set out, must be drawn up and passed on to those who have to deal with the particular case. In addition, therefore, to the physical and psychological examination of the child himself, two further sets of facts will be required before his mental status can be really understood—first, those relating to his present environment, and secondly those relating to his history in the past.

In every instance a careful scrutiny of the general background of the child's daily life is, we shall find, essential. In particular, the economic, sanitary, intellectual, and moral character of his home should always be made the subject of first-hand and systematic report. Nowadays, thanks to an efficient and a growing social service, details about the material conditions of the home are nearly always accessible. Too often, however, little is known or noticed of its cultural level and its emotional tone: yet these, as we shall learn in

a moment, may have an even profounder effect on the intellectual development of the backward child than dirt, poverty, overcrowding, and the more conspicuous disadvantages that leap to the inquiring eye. Every social worker, therefore, who calls on the parent to collect such information should possess what is sometimes called a psychological or psychiatric point of view. This in turn can best be learnt by a course of training at a psychological clinic for child guidance.

(3) *Family History.*—The retrospective parts of the report should embrace the personal history of the child himself, and the history of his family so far as the details are obtainable. As a rule, the visitor who investigates the home conditions will be able to append her impressions of the other members of the household and the results of her tactful inquiries about remoter relatives.

Whether there are other relatives in the family who are dull or mentally defective, unable to read or write, or incompetent in practical affairs, is a point of special relevance. Psychological tests, as we have already noted, seek to distinguish what is innate from what is accidental. But the distinction is elusive; and no test of itself can definitely separate the two. Hence the presence of defects or disabilities in the family, similar to those exhibited by the child, will always have a direct bearing on the outlook for the child himself. What is inborn is not necessarily inherited; but what is inherited is necessarily inborn. And the presence of hereditary defects is bound to modify or limit the suggestions for treatment.

Nor is it sufficient to confine the report to the parents alone. In general, a child resembles his brothers and sisters far more closely than he resembles either his father or mother. Hence the peculiarities of the other children in the family may throw much light on the endowment of the child to be studied. Further, it has been argued that certain mental capacities may obey what are known as Mendelian laws of inheritance. Qualities transmitted in accordance with these laws are apt to skip a generation; they pass from the first generation to the third without visibly emerging in the second, so that the second may act

solely as a carrier. Accordingly, wherever the particulars are accessible, the family history should extend to the child's grandparents, and to his uncles, aunts, and cousins, as well.

Whichever relative is under consideration, the notes should cover, so far as possible, not merely the person's intellectual and temperamental status, but also his (or her) physical disabilities and ailments, especially those that suggest an inheritable constitution or diathesis, such as tendencies towards rheumatism, tuberculosis, or nervous instability, in their manifold forms. The influence of heredity, however, as the modern biologist continually insists, is far more elusive than was formerly supposed. In the past, a backward child was too often certified as innately defective, because another instance of deficiency had been reported in his family. And the stupidity of one or two blood-relatives is no conclusive proof that the apparent stupidity of a pupil is due to something in the breed. Galton's 'law of regression,' a law definitely founded on statistics, exists to remind us that the children of geniuses are rarely so brilliant as their parents; and, by the same principle, the offspring of the dull are seldom quite so dull. The chip may be better than the block.

(4) *Personal History*.—The personal history of the child, both pre-natal and post-natal, will, as a rule, be pieced together from details supplied by the mother. The relevant points will be elicited either by the social visitor calling at the home, or by the teacher, psychologist, or medical officer, in an interview with the mother at the school; in the case of an older child her story will be supplemented by the records of past inspections entered on the medical card. A full and comprehensive inquiry should include conditions of gestation and birth, dates of sitting up, of walking, of talking, of acquiring habits of cleanliness, of dentition, and, later on, of pubescence—in fact, the general course of the child's whole development, together with the details and after-effects of childish illnesses, shocks, accidents, and other relevant experiences.

(5) *School Report*.—The child's progress at school and his behaviour in and outside the classroom are of such direct significance that they should form the subject of separate

reviews. These will doubtless be drawn up by persons specially informed—usually the child's present and previous teachers. The school report should comprise not only a statement of the child's present educational attainments, but also a survey of his past progress, stage by stage, since first he was admitted as a pupil; the age at which he entered, and at which he was promoted from the infants' department to the junior, from the junior to the senior, and from one class to the next, the extent to which he has been absent or irregular in his attendance (preferably with figures, dates, and causes when known), the general methods of instruction in vogue at the school—these various points, when taken together, explain much that might otherwise be obscure.[1] The statement of attainments should, if possible, be based on standardized tests; and typical specimens of his work should be appended. What is even more important is a statement of the methods by which the child has been taught both in his present and in his previous classes. If necessary, the psychologist can test the child's attainments for himself; but it is not so easy for him to guess whether the regular method of teaching reading, for example, has been purely phonic, purely look-and-say, purely alphabetic, or perhaps a combination of these or other devices, or whether the method has been so frequently changed in the different classes or departments that the child has become completely confused, or again whether any efforts have been made to teach the child individually, and, if so, how he has responded.

(6) *Conduct Report.*—It has become a commonplace that mental deficiency is as much a matter of social conduct as of intellectual or educational capacity; and what is true of downright deficiency is equally true of apparent dullness. Even the child's intellectual and educational progress in the classroom may depend as much on qualities of character as upon sheer ability. With the dull and the backward, too, as with the mentally deficient, the ultimate issue will be the

[1] Form 41D of the Board of Education—the 'form of report by head teacher on an educationally retarded child' suggested by the Board as a preliminary to the medical examination of defectives or the transference of pupils to a backward class—may be conveniently used for this purpose.

child's probable efficiency as a worker and as a citizen ; and this cannot be gauged from a bare statement of his success at his lessons.

His practical commonsense, his emotional and moral tendencies, his personal and social habits, as shown alike in the playground and in the classroom, should, therefore, be observed and noted down. I suggest, however, that the report on behaviour and disposition should be made the subject of a separate document ; otherwise it is likely to consist solely of one or two vague adjectives, or get omitted altogether. Moreover, while the head teacher is generally the best person to draw up the report on school history and attainments, it is often the class teacher who has the best first-hand knowledge of a pupil's character. And it is a safe rule that every assistant who has had charge of the child should be consulted, before the accounts of his school progress and conduct are drawn up.

The statement should describe, not impressions or suspicions, but, so far as possible, actual behaviour. In a court of law the evidence relating to a man's character must consist of actions that can be proved ; and the principle is sound and scientific. Even answers to explicit questions on a printed form—' Is he obedient ? ' ' Is he easily led ? ' ' Is he unduly timid ? ' ' Bad tempered ? ' ' Amenable to ordinary school discipline ? '—mean little or nothing, so long as the informant confines himself to a bare ' Yes ' or ' No ' and appends no concrete illustration of the child's abnormal conduct. It is better, therefore, to record actual incidents than to rest content with curt or abstract generalizations : it is, for example, far more illuminating to say that the child has, under such and such circumstances, stolen such and such sums, and spent them on sweets, or the cinema, or flowers for teacher, than merely to dub him ' a kleptomaniac ' ; it is far more helpful to relate how he has pushed another boy into the water, with what provocation, and with what result, than to assert that he ' seems homicidal.'[1]

[1] For purposes of research and even for practical summaries and reports it is often convenient if the conduct-record is summarized in the form of a list of character-qualities (such as that given in my volume on *The Young*

Sometimes the most suggestive points in the child's behaviour will be observable, not on the school premises, but at home or in the street. As a rule, these come to the ears of an interested head teacher, often at wide intervals of time, through the statements of school-fellows, attendance officers, or parents. Where, however, there is an efficient social service or care committee organization in connexion with the school, the crucial facts will be gathered by the care committee's visitor when she calls at the home: once more, therefore, it proves essential that such visitors should have some knowledge of the important items to observe and the relevant questions to ask, and, generally, that they should possess what I have termed the social psychologist's standpoint.

Case-summary.—These, then, are the principal sources from which information may be gleaned, and these are in brief the main methods by which the child's personality may be studied. As a rule, with the dull, the backward, and the possibly defective—in fact, with all who are intellectually subnormal—the centre of the inquiry and its most convenient starting point will be the quantitative results of the scholastic and psychological tests; but the main task of the psychological examiner will be to interpret these results in the light of the more comprehensive data furnished by the supplementary reports.[1]

Delinquent) with quantitative ratings attached. For the method of rating, cf. above, p. 24, and for an illustration *The Measurement of Mental Capacities*, *loc. cit. sup.*, p. 29. See also Chapter XV below on 'Defects of Temperament and Character.'

[1] Research is urgently needed as to the relative prognostic value of these different fields of investigation. In the course of a prolonged investigation referred to below (see pp. 159–61) I endeavoured to determine what points in the first inquiries about a young school pupil proved to be most significant for purposes of prediction as judged by his subsequent history. The method adopted was roughly as follows. Marks or ratings were given for each point in the original case-summary; and correlations were then worked out between these earlier findings and the child's later record. From the correlations approximate weights could be derived for each set of features usually observed, and the original marks or ratings weighted accordingly. A total mark may thus be allotted to each individual and compared with the average mark obtained by the general mass of normal pupils. The difference can be taken as forecasting his probable degree of backwardness in the

Where there is no psychologist attached to the educational staff, and where no psychological clinic is available for the investigation of individual cases, there the task will fall largely upon the teacher. In the long run, he will find that this, so far from adding to his many burdens, really lightens them. In point of fact, I have found that, where a backward class has been instituted, the teacher in charge has usually discovered for himself how much his work is aided by collecting information of the kind I have described.

I would venture, however, to make two suggestions. First of all, the causes that I have touched upon should be explored systematically. Their discovery should never be left to chance. When the teacher sees the mother, for example, he should tactfully question her on the points I have indicated, and not simply trust that she will spontaneously volunteer all that is necessary; and, again, he should at least seek to assure himself in every case that the child's vision and hearing are normal and not wait for the doctor to draw his attention to the matter.

future. The weights deduced were as follows: intelligence tests, ·7; attainments tests, ·6; school report, ·5; family history, ·4; anthropometric examination, ·3; medical examination, ·2; home circumstances, ·2; personal history, ·1; conduct report, ·1. (The relative importance attached to some of the fields of inquiry may seem at first a little surprising—*e.g.* the low weight accorded to the results of the doctor's examination: but we shall find that their relative size is, for the most part, quite in keeping with the causal significance of the various factors, as disclosed by the results of the main research to be described in the chapters that follow.)

In this way it would be easy to pick out at a very early age those pupils who are most likely to become 'problem children' in the classroom; and consequently it should be practicable to give special attention to these cases from the very outset, and so, to a large extent, to ward off a good deal of the preventable backwardness, and attempt some compensation for whatever is not preventable.

Even with intellectual subnormality some such method would seem to be far more effective than relying solely on mental tests: with temperamental subnormality—*i.e.* with potential neurotics and delinquents—this wider view is essential. In dealing with delinquent cases I have adopted a similar procedure; and there, it is interesting to observe, the past history of the child proves far more significant than the results of a single psychological examination. On the other hand, with potential cases of backwardness, as will be seen from the weights just cited, the results of the psychological and scholastic examination seem to have more prognostic value than any other field of inquiry.

Secondly, the teacher who has the time and energy to carry out these individual studies should not be content merely with eliciting the relevant data ; he should set them down on paper. This will require something more than the art of brief biography: what is wanted is a systematic epitome of the facts, comprehensive and complete, but business-like and scientific, rather than literary or loquacious, a record to be scanned rather than a story to be read.

Various ingenious schemes have been devised by enterprising teachers for entering such particulars under the appropriate headings. The headings are not always the best that could be used : they differ according to the type of case that the teacher finds most frequent, according to the sources of information accessible to him, and according to the time at his disposal. It may therefore be helpful if I append a typical schedule [1] which may indicate in detail the ground that would be covered in a full and extensive inquiry ; for simple practical purposes the teacher can select, from the points there enumerated and classified, those rubrics that seem most appropriate for his particular pupils.

[1] See Appendix I. Much light has been thrown on the methods of mental testing and on the techniques for statistical analysis originally worked out by educational psychologists in peace-time, by the application of similar procedures to the problem of testing recruits for the Army and other fighting services. As a result, we now have a far clearer idea of what our tests measure, and of the most speedy, inexpensive, and practical ways of applying them on an extensive scale. A preliminary account of some of the devices used will be found in *Brit. J. Psychol.*, XXXIV, 1943, pp. 1–19, 'Validating Tests for Personnel Selection,' and in *Psychometrika*, IX, 1944, pp. 219–35, 'Statistical Problems in the Evaluation of Army Tests.' For the teacher perhaps the most important result is the verification of the same kinds of mental ability among adults as among children. Thirty years ago the first attempt at 'multiple factor analysis' revealed evidence among school pupils for at least four main types of ability and disability—referable to four main factors, 'general intelligence,' and 'verbal,' 'numerical,' and 'manual' capacities (*Distribution and Relations of Educational Abilities*, 1917, pp. 56 *et seq.*) : much the same factors, now briefly labelled *g*, *v*, *n*, and *k*, have emerged from factor-analyses of test-data obtained from the fighting services (cf. C. Banks, 'Applications of Factor Analysis to Psychological Problems with Special Reference to Army Selection,' 1945, and below, p. 459).

CHAPTER IV

DEFINITION AND FREQUENCY OF EDUCATIONAL RETARDATION

Need for a Quantitative Definition.—We have now reviewed the chief methods available for investigating cases of suspected backwardness and measuring the abilities of those who are mentally subnormal. We are thus in a position to attack the all-important question raised at the outset—how far must a child fall below the average standard before he can be regarded as needing special educational provision, that is, as being ' educationally subnormal ' in the technical sense ?

A precise definition in numerical terms may seem somewhat arbitrary and pedantic. Nevertheless, both for practical purposes and for theoretical, some such definition is essential. It is needed, first, for practical reasons. Before we can provide for these cases, we must know how many will need it ; and to count up the number will be impossible, until we have settled who are to be put into this category and who are to be left outside. Secondly, a clear elucidation of the term is equally wanted for scientific work : we can attempt no first-hand inquiry into the causes of educational backwardness unless we find and formulate an unambiguous description of the cases we mean to study.

But surely, it will be said, every teacher knows a backward child when he meets one. No ; for even teachers disagree. Their standards vary with their experience ; and their insight may be at fault. I recollect, among my London cases, one boy who was regarded by his master as a sharp and promising lad for a denizen of a Paddington slum—as in truth he was ; but no sooner had his family migrated to the superior borough of Kensington, than he was sent forward from his new school, where all the youngsters were exceptionally clever, to be examined as a possible defective. The

dullards of Stoke Newington seem smart scholars in Bethnal Green, and the star pupils of Southwark and Bermondsey ignorant and illiterate in the better schools of Lewisham or Hampstead.

Even within one and the same department, the teacher is apt to judge a child mainly by his place in class, not by his position for his years. An undersized boy of 12 who is doing well in Standard IV may thus pass muster as a satisfactory pupil, because his age is overlooked; while in the same class a boy of 8 who gets most of his sums wrong may be suspected of being below normal. Such confusions may be increasingly rare; but, so long as they exist, they accentuate the lack of a uniform definition and criterion.

The need is all the more pressing, because, as I have already shown, the various grades of intellectual ability are nowhere clear-cut. The backward shade into the normal as the mentally deficient shade into the backward. Some boundary line, sharp but arbitrary, must accordingly be laid down. It does not exist in nature. It cannot be discovered by each teacher for himself. It must, therefore, be agreed upon by all, if only as a matter of convenience and convention.

Range of Variation among School Children.—Let us bear in mind, from the very outset, the vast range of individual differences in intelligence brought to light by psychological tests. A single teacher confined to a single school, recruiting its pupils from a fairly homogeneous neighbourhood, can form no notion of how widely boys and girls may differ one from another. The modern politician still quotes the celebrated dogma that 'all men are created equal.' But a wholesale survey of the school population quickly leads to the opposite pronouncement. In the psychological sense as distinct from the political, not only are men created unequal, but the extent of the inequality as revealed by careful testing surpasses anything before conjectured.

In a survey carried out upon all the children in a representative London borough—a census covering more than 30,000 cases—it was found that, within the elementary schools, the mental ratios actually varied from below 50

per cent. to above 150 per cent.[1] This means that, at the chronological age of 10, the brightest may already have passed the level of an average child of 15, while the dullest have not yet arrived at the level of an infant of 5. *In the middle of their school career, children of the same calendar age spread out over a total range of more than ten mental years.* Consequently, to force upon every child one and the same rigid type of instruction is clearly to attempt the impossible.

Upper Limit for the Backward.—Not every child who falls behind the general standard needs special administrative provision. The boy who is backward by no more than one year can well be accommodated in a class where the average age is somewhat below his own. This is everywhere a common practice ; it carries with it little or no disadvantage, so long as the ages are not too freely mixed. A child of 10 —to take a concrete instance—ought to be working in Standard IV. Should he fall somewhat below the average—if he is equal, let us say, to the work in Standard III, a place may still be found for him in this lower class, with no great detriment to himself or to his fellows. If, however, he is fit only for Standard I or II, he must either be relegated to one of the bottom standards of the school, or else promoted, on the ground of age and size alone, to some higher class where the work is far beyond his mental reach. But up into these bottom standards come the brightest entrants from the infants, three or four years younger than himself: such an association of big and little, side by side in the same classroom, is eminently unwise. Finally, should he be fit only for Standard O (Grade iii), and should further inquiry show that his backwardness is due not to absence, ill-health, or other external factors, but to delayed development of general intelligence, then, presumably, he will be deemed fit for transference to, a special school for the mentally defective—provided such a school exists within his area.

I have accordingly put forward the following definition. I regard as educationally backward in the technical sense *all those who in the middle of their school career would be unable to do the work of the class next below that which is*

[1] *Mental and Scholastic Tests* (1921), pp. 160 *et seq.*

normal for their age.[1] To be exact, and to be applicable at every age, the lines of demarcation may be expressed in terms of an educational ratio. To make the calculation simpler, let us keep for the moment to the children aged 10. In order to be capable of Standard IV work, they should have an educational age averaging the same figure, namely, 10·0, and ranging from 9·5 to 10·5. Those capable of work in Standard III will have an educational age averaging only 9·0, and ranging, therefore, from 9·5 down to 8·5. Thus, a ten-year-old who is unfit even for Standard III must have an educational ratio below $\frac{8\cdot5}{10\cdot0}$, that is, below 85 per cent. This yields a convenient figure that can be applied regardless of age. Precision to a decimal point may at first sight look pedantic; but a fractional difference in the actual

[1] This definition is accepted in the Board of Education's recent *Handbook of Suggestions for Teachers* (1927, p. 34). It accords pretty closely with the practice of teachers themselves. Where special classes for the backward have been formed, and the mental ratios of the pupils tested, it appears that they usually vary from about 70 to 85. Recently, in educational articles, official reports, and discussions among teachers themselves, it has become customary to describe the backward child as one who is backward by at least two classes or years. If this relates to the child about the middle of his school career, it describes well enough the ten-year-old who is working, or is fit to work, not in Standard III or IV but in Standard II or I. But it is not sufficiently exact for our purpose. Certainly II from IV leaves two; but this rough method of calculation ignores the twelve months' range covered by a single standard. Thus 'fit for Standard II' really means having a mental age that may vary from about 7·5 up to about 8·5 years. (In London, where promotions were considered not once a year but once every six months, the rules of the education committee laid down that the *average* age of the children promoted to Standard II should approximate to 7 years 9 months, and so on, allowing one year for each standard: in practice this meant that the youngest were promoted to Standard II at about the age of 7½ and to Standard III at about the age of 8½.) The proper subtraction to make, therefore, in calculating the upper line of demarcation, is 10·0 — 8·5 = 1·5. Thus, at the age of 10, the borderline for backwardness is a retardation of 1½ years (not, as is so commonly stated, of 2 years), or, in terms of the ratio, 15 per cent.; and the borderline will therefore be a mental ratio of 85, as indicated in the text, not of 80. Moreover, except near the age of 10, a criterion of 2 years' backwardness would be misleading. At 14 a child who is backward by 2 years is but slightly retarded, and hardly to be deemed 'educationally subnormal' in the technical sense; at 6, with a backwardness of 2 years, he would in the old days have been classed as mentally defective.

borderline adopted will make a very large difference in numbers when we come to reckon up how many among the whole population fall within the definition accepted. Accordingly, in the following pages the phrase 'educationally subnormal' will be used to mean *any educable child whose educational ratio falls below* 85 *per cent.* What this implies in terms of ages and the old-fashioned 'standards' is shown in the right-hand columns of Table II (p. 85).

Classification.—Now, as we have already seen, among the eleven types of 'handicapped children' officially recognized, the Education Act of 1944 has expressly included a special category for what it calls 'educationally subnormal' pupils; and it has become the duty of each education authority to ascertain all such cases in its area and to make suitable provision for them. In the Act itself this and other categories are not explicitly defined; but supplementary instructions (*School Health Services and Handicapped Pupils, Regulations*, Statutory Instrument No. 1156, 1953) have been issued explaining what kinds of children are held to fall under the designations now proposed. The 'educationally subnormal' are here defined as 'pupils who by reason of limited ability, or other conditions resulting in educational retardation, require some specialized form of education, wholly or partly in substitution for that normally given in ordinary schools.'

The new category, we are told, is intended to include three main groups: (1) 'children who in the past were certifiable under Section 55 of the Education Act of 1921' (these roughly correspond with the group usually referred to in medical and psychological textbooks as 'feebleminded children' or 'educable defectives'; in the Act of 1921 they were described as 'incapable of benefit by instruction in ordinary elementary schools, but not incapable of benefit by instruction in special schools or classes'); (2) 'children who are retarded by reason of limited ability,' but presumably less retarded than the former group (they correspond with those formerly described, in a somewhat technical sense, as 'the dull'); (3) 'those who are backward in the basic subjects because of other conditions' (i.e., 'the merely backward'). The upper borderline, it is suggested,

should be an educational age (and, for the dull, a mental age) of about 8 at the chronological age of 10, that is, an educational 'quotient' or ratio of about 80 per cent. These figures, it is added, are to be regarded only as rough and general guides; and in actual practice there will be no need, when considering any particular case, to split hairs over whether the child's educational ratio with this or that standardized set of tests is 80 or 85. Here I shall retain the latter figure, since it is the figure used in the majority of the more accurate surveys.[1] In any given area the borderline adopted at any given moment must of course depend on the accommodation; and in hardly any area is sufficient provision at present available for all who may need 'some specialized form of education.'

Almost inevitably the progress made so far towards ascertaining cases of 'educational subnormality' has been slow. However, as successive surveys have indicated, within a period of thirty years or so the changes in the distribution of intelligence among the population as a whole are comparatively slight. Hence the results of surveys undertaken before the Act came into force may still be accepted as furnishing the best information we possess as to the general size of the problem. The numbers reported in such surveys usually relate to the three main types of educationally subnormal children already mentioned. We must therefore first consider what are the precise borderlines which have commonly been adopted for distinguishing the three. Whether or not the three require different forms of provision we shall have to discuss later on.

The Borderline for the Educable Defective.—To begin with, the group cut off by the upper borderline suggested

[1] *The Report of the Mental Deficiency Committee* (pp. 143–4) notes that 'where schools or classes for the backward have already been instituted, and exact measurements made, the mental ratios of the pupils usually range between 70 and 85.' For the largest towns they recommend the figure of 85. 'In the smaller towns and in rural areas the classification will be less finely differentiated'; and here, they suggest, the borderline might be lowered to 80. On the other hand, the Scottish Research Council, so far from lowering the ratio, would prefer to raise it to a round figure of 90; but that would make nearly one-quarter of the school population technically 'retarded' (*loc. cit.*, pp. 105, 122).

above will include an appreciable number of those formerly classed as 'mentally defective.' In Britain, as in most other civilized countries, psychiatrists and psychologists have been accustomed to subdivide the mentally defective themselves into three sub-classes or grades—idiots, imbeciles, and feebleminded. Idiots and imbeciles, roughly those whose mental ratios fall below 50 per cent., are excluded from the public elementary school altogether, as being in-educable. But their numbers are relatively small, well under 2 per thousand ; and they will not concern us here. The highest grade of all—those usually termed in this country the 'feebleminded'—consists solely of what are held to be 'educable' cases ; and until recently, in the larger areas at least, were generally transferred, after medical certification, to special m.d. schools.

Before the introduction of psychological tests, the borderline for certifying such cases varied widely from one certifying officer to another. And my first task, when appointed psychologist to the Education Department of the London County Council, was to formulate a more precise line of demarcation for the county as a whole. A preliminary survey showed that, taking an average for the different boroughs, the line was generally drawn at what proved to be a mental ratio of about 70 per cent. The doubtful cases ranged for the most part between 70 and 75 per cent. ; and in such instances the child's inherent dullness was usually aggravated by some additional peculiarity—a special disability for reading, a mild temperamental disorder, some physical defect, or, most frequently of all, troublesome behaviour in and out of school. Researches carried out in other areas (Liverpool, Birmingham, and elsewhere) indicated that this average borderline corresponded with the general practice of the more experienced teachers and school medical officers, when nominating or certifying cases as in need of education at a special school ; and, as it subsequently turned out, much the same standard was proposed or accepted by psychologists and doctors abroad.[1] It was also adopted by the joint committee of the Board of Education and the Board of Control in laying down standards

[1] *Mental and Scholastic Tests*, p. 163 and refs.

for their investigator in their inquiry into mental deficiency.[1]

Frequency of Mental Deficiency in Schools.—Accepting, then, a mental ratio of 70, we have next to inquire how many children fall within the category thus defined. In London I found that the proportion of educable defectives was almost exactly 1½ per cent. of the total age-group; in many of the rural areas the proportion rose to nearly 3 per cent.—double the urban figure. In both areas there were rather more boys than girls. These estimates, and the proportionate differences according to sex and area, were subsequently confirmed by surveys in other parts of the country.[2] And on this basis it seems evident that, in the whole of England and Wales, there must be well over 100,000 children who would have been considered high-grade defectives, needing education in special schools.

Retarded Children as a Single Educational Unit.—No longer, however, do we believe that the mentally defective form a distinct and isolated group, sharply marked off from the normal. Of those who would formerly have been certified and removed to special schools, nearly one-half were in effect decertified on reaching the age for leaving school, and were thus allowed to take their place in the general community with youths and girls from the ordinary school. The conclusion seemed inescapable that such children are lacking not so much in social capacity as in scholastic capacity: they are incompetent pupils rather than incapable citizens. Accordingly, as I ventured to argue in several previous publications,[3] it would seem highly inexpedient to

[1] *Report, loc. cit. sup.*, Part IV, p. 52. According to Dr. O'Connor and Dr. Tizard, the average I.Q. of the feebleminded in institutions is as high as 70, though others of this level live comparatively normal lives outside (*Social Problem of Mental Deficiency*, 1957).

[2] *Mental and Scholastic Tests*, p. 168. Report, *loc. cit. sup.*, p. 183. Scottish Council for Research in Education, *The Intelligence of Scottish Children* (1933), p. 123.

[3] The arguments and the relevant evidence were set out more fully in various L.C.C. publications and in my memorandum to the Mental Deficiency Committee: the reader will find them summarized in the pre-war editions of this book. As I there contended, 'the education which such children require during their school years should approximate rather to the instruction received by the more backward among the normal than to the limited training received by those who, when they are grown up, will always

continue treating the two groups—the educable defectives, on the one hand, and the dull and backward, on the other—as two distinct administrative entities. They should be regarded as a single group, presenting a single educational problem.

The theoretical arguments may be supplemented by practical considerations of a very urgent kind. It appeared that only about 17,000, *i.e.* barely one-sixth of all the educable defectives in the country, were actually accommodated in special schools. Except in populous areas, it was, and it still is, scarcely feasible to meet the need by simply opening more schools expressly for children of this type. Obviously in an area whose total population is less than about 6,000 it would be impossible to fill such a school at all; and in rural districts the difficulty is even greater. Hence in areas such as these the policy recommended was in point of fact operative already: it seemed tacitly agreed, though seldom explicitly recognized, that in these cases the only practical solution was to group the 'defective' with the 'dull and the backward,' who were after all far more numerous. The chief requirement, which still remained unfulfilled, was to provide a scheme of education which, though envisaging primarily the dull, might also serve for the educable defectives.

In those areas where special schools have already been set up, or could be set up, all that is now needed, so far as the more extreme cases of subnormality are concerned, will be to transfer them thither as before, but without the stigma of the old name or the old certification. At present, according to the latest official reports, the total number already in attendance at special E.S.N. schools is approximately 23,000; and another 12,500 are described as awaiting places in such schools (*Education in 1955*, Cmd. 9785, Tables 44 and 51). In the main, the children thus accommodated are, or should be, pupils in whom the 'educational subnormality' is permanent and comparatively severe: at the moment there is ample evidence to show that

need some form of community care'; this principle has now been embodied in the Act of 1944 and in the regulations issued by the Ministry dealing with such cases.

in many areas those actually transferred do not include *all* who are most seriously handicapped, and do include a small proportion of relatively mild and even remediable cases. Moreover, the boys in such schools outnumber the girls far more than the test-results would lead us to expect. Hence there can be little doubt that the head teacher is often inclined to give priority to those particular youngsters who have proved to be a nuisance in school or in class rather than to those who most urgently need a special type of instruction on the ground of intellectual disability. However, the figures are rapidly altering from year to year; and there still seems a good deal of uncertainty as to where precisely the borderlines should in practice be drawn.

Varying Borderlines for Areas of Different Types.—In the smaller towns and in rural districts, as I have already argued, there is no cogent reason why the limits or borderlines for the retarded children who are to receive special educational provision should not vary with the special needs and facilities in each particular locality. For example, where only a single school or type of school can be provided, the limits may well be narrowed to avoid mixing too heterogeneous a collection of pupils; and in such cases the mental ratios of 55 and 80 might perhaps be taken as the most convenient lower and upper limits.

In the larger towns finer differentiation and further sub-classification are both possible and advisable. Although such towns are few in number, nevertheless, in virtue of their gigantic size, they account for a vast proportion of the whole population of the country. Accordingly, in what follows I shall have these more populous areas mainly in mind. Here the entire group can readily be split into at least two sections, a smaller section corresponding roughly to the educable 'defectives' previously accepted at special schools, and a larger section comprising the dull or backward in the more restricted meaning of that phrase. On the principles suggested above, the former will have mental ratios from about 50 to 70; the latter, ratios ranging from 70 to 85.

To some readers the notion of a mental ratio may still be a little difficult to interpret in practice. Accordingly, it may

be helpful to convert the abstract ratio into concrete mental and educational 'ages' and the equivalent 'grades' and 'standards.' Although school classes are no longer arranged or labelled in this way, many teachers still find it convenient to think in terms of these traditional designations as defined by the old Board of Education codes, the several 'standards' denoting by their numbers the attainments reached by the average child one, two, or more years after entering the primary school. Table II puts into explicit form the conventional borderlines upper and lower, as thus defined. Since the lower limit for 'backwardness' forms the upper limit for 'mental deficiency' (as interpreted in terms of the older Act), the second of these columns indicates the borderline for what may be conveniently termed the 'educable defective.'

TABLE II. UPPER AND LOWER LIMITS OF BACKWARDNESS AT EACH AGE[1]

Chronological Age.	Lower Limit.		Upper Limit.	
	Mental Age. Years.	Approximate Standard.	Educational Age. Years.	Approximate Standard.
14·5	10·1	Bottom of Stand. IV	12·3	Top of Stand. V
13·5	9·4	Middle of Stand. III	11·5	Middle of Stand. V
12·5	8·7	Middle of Stand. II	10·6	Middle of Stand. IV
11·5	8·0	Bottom of Stand. II	9·8	Top of Stand. III
10·5	7·3	Middle of Stand. I	8·9	Top of Stand. II
9·5	6·6	Middle of Grade III	8·1	Top of Stand. I
8·5	6·0	Bottom of Grade III	7·2	Top of Stand. O
7·5	5·2	Bottom of Grade II	6·4	Middle of Grade III

[1] In calculating the borderlines I have taken chronological ages in the middle of the year (7·5, 8·5, etc., instead of 7·0, 8·0, etc.). In practice this will be found more convenient, since, when teachers and medical officers speak of chronological age, they almost invariably mean age last birthday, thus implying an average of 7½ rather than 7·0.

It will be noted that 'backwardness' (in the narrow and technical sense in which the term is here used) depends on educational age; and 'deficiency' upon mental age. Since a child's educational level is apt to be below his mental age, the standards given in column 3 will be, if anything, a little too high if interpreted as lower limits for educational attainments. For purposes of the surveys here described, 'educational age' was taken to be the average of the child's equivalent age for the basic subjects—reading, spelling, and arithmetic—as judged by the norms given in *Mental and Scholastic Tests*.

Frequency of Backwardness.—How many children are backward in this sense ? What proportion of the school population falls within the limits thus laid down ? In a careful survey carried out in London just before the war, and confirmed by minor surveys since, I calculated that rather over *10 per cent. of the total school population were definitely backward.* This means that throughout the county, excluding the mentally defective and leaving infants out of account, the number of backward scholars must amount to at least 40,000.[1] Much the same proportion, no doubt, holds good of nearly all the industrialized parts of Great Britain. From time to time, for various districts in the country, the reports of the school medical officers contain estimates under this head. For towns the returns seem to vary from 0·8 per cent. at Leeds to 14·6 per cent. at Sunderland ; for rural areas the figures are vaguer and far higher. Owing to the lack of a generally recognized standard of backwardness, the individual estimates are discrepant, and have little value by themselves. The average, however, works out at about 10 or 11 per cent., and is thus consistent with my figure.

Hitherto, so far as I am aware, only one other English educational authority has expressly instituted a systematic survey by psychological methods. In 1920, at the request of the Education Committee at Birmingham, Dr. Lloyd and I carried out a census of backward children in that city. The census was based primarily upon the method of sampling : typical districts and schools were selected ; and from the results it was calculated that, 'in all the senior departments[2] of the Birmingham schools, as many as 8,000 children must be technically backward' ; that is, once more, a proportion of about one in ten.[3]

For rural areas an estimate of the number of retarded children is more difficult to procure. According to the figures of the Royal Commission of 1904, 'the incidence of

[1] *L.C.C. Report on Distribution of Educational Abilities* (1917), p. 36.

[2] At the time of these surveys the term 'senior department' was generally used to cover all departments except infants'.

[3] *Report of an Investigation of Backward Children in Birmingham* (City of Birmingham Stationery Department, 1920), p. 5.

mentally defective children is decidedly greater in the towns than in the country ' [1]; and it has sometimes been inferred that the same held good of the dull though not perhaps of the backward. ' The rural child is healthier and therefore more vigorous in mind as in body : but educationally he is often ignorant or even illiterate.'

As we have seen, however, more recent investigations leave no room for doubt that mental deficiency is, on the whole, more prevalent in the country, not less ; while the amount of dullness seems to vary far more widely from one country district to another than it does from town to town. From my own limited inquiries, it would appear that, if it be legitimate to ignore the wide local variations and to strike a rough average for the whole country, the proportions both of mentally defective children and of the dull and backward may be assumed to be about twice as high in rural areas as they are in the bigger towns. The figures are highest of all in those parts where the exodus to industrial centres has drained the adjacent countryside of its brightest families ; they are lowest in those remoter corners that are as yet unaffected by this emigration. Thus, I calculate that, if the same standards are preserved, the average percentage of backward children in rural areas must amount to no less than 20 per cent.[2] If these proportions are applied to the school population in rural and urban districts respectively, it would seem that in the whole of England and Wales, between the ages of 7 and 14, there must be at least half a million who are so dull and backward as to be in need of special educational provision.[3]

About the size and the urgency of the problem, therefore,

[1] For a discussion of this problem, see Tredgold, *Mental Deficiency*, p. 160.

[2] I base these statements partly upon small surveys carried out by my former students and myself in villages in various country districts, and partly on the results of group tests independently applied by teachers and others and published in journals or communicated privately.

[3] The *Joint Report on Mental Deficiency* suggested a figure of 300,000. The difference is due chiefly to a difference in the estimates and standards for rural areas. There is, however, an urgent need for more precise evidence regarding the incidence of the various types of subnormality in different parts of the country. For more recent views on mental deficiency see A. M. and A. D. B. Clarke, *Mental Deficiency*, 1958.

no doubt can arise. Backward children are seven times as numerous as the mentally defective. Since the provision made for them is still grossly inadequate, they remain by far the most difficult group with whom the ordinary teacher has to deal ; and, as their subsequent life-histories show, it is from their ranks, rather than from those of the mentally defective, that the bulk of our criminals, paupers, and ne'er-do-wells are eventually drawn.[1]

[1] A note should perhaps be appended on the new terminology. When recommending the recognition of a 'new educational and administrative unit,' the members of the Joint Committee on Mental Deficiency discussed at some length the most appropriate name for the group thus contemplated ; and their final decision is embodied in their 'Recommendations in regard to Children' (*loc. cit.*, p. 157) : 'we suggest,' they say, 'that this unit should be known as the "Retarded Group."' The designation 'subnormal group' they use to describe those whose mental inferiority is permanent.

'Educationally subnormal,' the phrase now officially adopted, is doubtless a perfectly correct designation to describe those whose educational attainments are *below* the prescribed *norm* or standard. Nevertheless, particularly among the general public, the word 'subnormal' is apt to suggest 'not normal' in the more derogatory sense of 'constitutionally inferior.' How natural this interpretation seems to be was shown in a recent broadcast on 'educationally subnormal children,' when nearly every speaker treated the group as consisting solely of those who were transferred to 'E.S.N. Schools' on the ground of permanent and comparatively severe mental handicaps, *i.e.* as being identical with those who would formerly have been certified as 'feebleminded.' No reference was made to the fact that the vast majority of the pupils included in the group are, as numerous surveys have shown, cases either of remediable 'backwardness' or mere 'dullness.' Such misinterpretations have aroused a good deal of needless anxiety among many parents whose children have been 'ascertained' as 'educationally subnormal.' Very possibly this may prove to be merely temporary ; and in any case it should be the task of teachers to reassure the parent on such points.

CHAPTER V

CAUSES OF EDUCATIONAL BACKWARDNESS

Social and Scholastic Conditions

Need for Inquiry into Causes. — Backwardness is only a symptom. To rest content with just palliating symptoms by superficial treatment—a little extra pressure here, a little extra coaching there—is as disastrous in the school as in the hospital. With mental disability as with physical, we must find and fight not symptoms but causes.

What, then, are the causes of educational backwardness? In seeking an answer to this question, it is natural to begin by inquiring in what places or circumstances backwardness is predominantly found. By way of a preliminary, therefore, let us turn to a second survey—a survey of backwardness according to locality or district.[1]

Local Distribution of Backwardness.—I have taken the whole area of the County of London, and, in each of the electoral districts, I have endeavoured to obtain an estimate for the number of backward children in the schools under the Council. The calculation has been made by two separate methods.

First of all, I have analysed the data furnished by the preliminary examinations that are held half-yearly for junior county scholarships. The results provide a rough statistical survey of the educational attainments of the pupils in every department about the middle of their scholastic career. Under the revised scheme introduced in London in 1917, two qualifying papers are set in English

[1] The surveys described in this chapter were carried out between the years 1925 and 1935. As noted below, these and other inquiries made at various times between the two wars revealed comparatively little change in the essential figures.

and arithmetic, before the final examination is taken. Every boy or girl who is between the ages of 10¼ and 10¾, and is either in, or above the level of, Standard IV, sits or should sit for this preliminary examination. Those whose standard of work is too low, it will be observed, are by

TABLE III. DISTRIBUTION OF BACKWARD CHILDREN IN THE ELECTORAL DIVISIONS OF LONDON

County Electoral Division.	Backward Children (Percentage of Children attending Elementary Schools).	Junior County Scholarships Gained (per 1,000 Children attending Elementary Schools)	Mentally Defective Children. (Percentage of Children attending Elementary Schools).
Lambeth, N.	21·5	0·64	1·38
Southwark, N.	21·3	0·49	1·31
Bethnal Green, S.W.	20·7	0·66	1·33
Shoreditch	19·6	0·83	1·16
Rotherhithe	17·8	0·99	1·12
Limehouse	17·0	1·13	1·17
Finsbury	16·7	0·74	1·04
Bethnal Green, N.E.	16·5	1·51	·99
Islington, S.	16·2	1·15	1·20
Southwark, S.E.	16·1	1·15	1·01
Poplar, S.	16·0	1·52	1·02
Southwark, C..	15·3	1·74	1·05
Kensington, N.	14·4	1·22	1·09
Battersea, N.	14·1	1·50	1·04
St. Pancras, S.W.	13·5	1·41	1·11
Paddington, S.	13·4	1·28	·98
St. Pancras, S.E.	13·2	1·57	1·16
Mile End	13·1	3·31	1·17
Islington, W.	12·9	1·77	1·08
Whitechapel	12·9	1·94	1·09
Holborn	11·8	1·10	1·06
Bow	11·5	2·05	·83
Camberwell, N.	11·4	1·39	1·02
Paddington, N.	11·3	2·00	·88
Bermondsey, W.	11·1	1·40	·87
Deptford	10·9	2·71	·78
Abbey	10·6	1·48	·78
Hackney, S.	10·6	2·20	·98
Kensington, S.	10·5	1·76	·75
Peckham	10·5	2·99	1·03
Marylebone	10·4	1·27	·93
Islington, N.	10·2	2·57	·85
Greenwich	10·1	1·92	·75
St. George's	9·4	2·42	·74
Hammersmith, N.	9·2	2·95	·76
Fulham, E.	9·1	2·88	·86
City	9·0	2·0	·59

TABLE III—(*continued*)

County Electoral Division.	Backward Children (Percentage of Children attending Elementary Schools).	Junior County Scholarships Gained (per 1,000 Children attending Elementary Schools).	Mentally Defective Children. (Percentage of Children attending Elementary Schools).
Brixton	8·8	2·99	·84
Camberwell, N.W.	8·7	2·96	·68
Fulham, W.	8·6	3·80	·67
St. Pancras, N.	8·4	5·00	·64
Hammersmith, S.	8·0	2·99	·70
Battersea, S.	7·6	3·52	·74
Chelsea	7·6	3·61	·62
Woolwich, E.	7·5	1·51	·65
Norwood	6·3	3·75	·73
Woolwich, W.	6·3	4·12	·60
Kennington	6·1	2·89	·72
Islington, E.	5·9	2·98	·70
Clapham	5·6	4·69	·61
Stoke Newington	4·3	4·14	·55
Streatham	4·1	4·20	·59
Hackney, C.	4·0	5·69	·58
Hampstead	3·9	4·04	·71
Wandsworth, C.	3·9	5·49	·56
Dulwich	3·8	4·08	·52
Hackney, N.	2·9	6·17	·50
Balham	2·6	4·37	·49
Putney	2·1	5·71	·47
Lewisham, E.	1·7	8·29	·48
Lewisham, W.	0·7	7·34	·46
Correlation with Backwardness		− ·857	·932

regulation excluded, unless their parents expressly desire a nomination. But the number so passed over in any department or district can easily be ascertained. Then, by assuming a normal distribution, it is possible to calculate, from the truncated curve of marks gained by the selected group, a complete curve of marks for the school population within that district and between the age-limits assigned, much as a schoolboy can round off the entire circle when he is given a curtailed arc. From the reconstructed curve the proportion falling beyond any specified line of division—a mark, say, which would cut off the bottom 10 per cent. for the county as a whole—can at once be deduced for each particular area.

The calculations thus made were checked by a second and

independent method of assessment. Within every electoral division I endeavoured to obtain a grading for each of the Council's schools ranked or classified according to the educational standing of the pupils; I then took the best, the worst, and the median school in each area and tested complete age-groups. This enabled me to make a rough assessment for the percentage of backward children in schools of every grade or class, and so to compile an estimate for every electoral division in the county.[1] Although the methods of estimation are necessarily rough and approximate, the percentages computed in this way coincide very closely with those deduced from the results of the preliminary examination for junior county scholarships.

Taking as the upper limit of backwardness a borderline which would cut off the bottom 10 per cent. in the whole of London, I find that, in the separate electoral divisions, the proportions vary enormously. In North Lambeth and North Southwark, Shoreditch, and North West Bethnal Green, the proportion rises to 20 per cent. or more; in Putney and in East and West Lewisham it sinks to but 1 or 2 per cent.[2] (see above, Table III). The figures so obtained

[1] The data were for the most part procured during the course of my regular work for the Council. On being appointed psychologist in the education officer's department, the first duty enjoined upon me was to make a survey of the ordinary elementary and special schools with a view to discovering how many mentally deficient children were still to be found in the ordinary schools and how many normal children (if any) in the schools for the mentally deficient. To this end I visited all the special schools within the county, and, so far as possible, all ordinary schools where extremely backward or mentally defective children were likely to be found. As a rule, on each visit I tested a sample group of pupils either personally or with the aid of the teachers. For the grading of the remaining schools, I am indebted to the information kindly supplied to me by the Chief Inspector, the divisional inspectors, teachers, and others who were in a position to make the necessary comparisons.

[2] If we took into account the fact that in divisions where there is a large number of well-to-do families a considerable proportion of the children do not attend elementary schools, the percentages in areas of this type would be somewhat lower still. In Hampstead, for example, less than two-thirds of the children are scheduled for attendance at an elementary school (see Table IV, column 10). Elsewhere, however, the reduction in the percentage could not be very great.

have been made the basis of a map of educational backwardness (Fig. 1).

It will be instructive, first of all, to compare the incidence of backwardness with that of mentally defective children, on the one hand, and of junior county scholarship winners on the other. If backwardness is largely the outcome of weak hereditary intelligence, then mental deficiency, backwardness, and scholarship attainments essentially [1] represent three different levels or tiers in one and the same fundamental capacity, a capacity which is mainly innate and rises continuously from its lowest manifestations in the ineducable idiot and imbecile to its highest manifestations in the future scientific or literary genius. Between different individuals the extent of variation is, as we have seen, enormous; hence the average range of individual variation may differ appreciably in different districts. For the moment, however, let us assume that these effects are negligible; then the fact that in one district the general population had a lower average than in others would mean that it was producing, not only a larger proportion of backward children, but also a larger proportion of mental defectives and a smaller proportion of potential scholarship winners.

We may put this inference to the test. But before we can do so, there is a minor obstacle that meets us in compiling estimates for the incidence of mental deficiency. The official figures give the number of children in attendance at each of the special schools by name. Now the location of the school attended by any particular defective is no safe guide to his residence. During the time of my survey, at least a dozen electoral divisions had no special schools within their boundaries, and the majority had only one or two: on the other hand, a few contain schools accommodating elder boys or elder girls and even residential cases, drawn from several different areas. Some more accurate method, therefore, is desirable for estimating the number

[1] I say 'essentially,' because it would be impossible to deny the influence of many other factors—post-natal disease in a few of the defectives, special handicaps or disabilities in the case of the backward, special educational opportunity or assistance in many of those who gain scholarships.

of defective children within each electoral division. Accordingly, during my tour of inspection of the special schools within the county, I secured from each head teacher the number of his pupils who lived in the different electoral divisions. These are the figures on which my calculations will mainly be based.[1]

In Table III the various electoral divisions are arranged in order according to the apparent prevalence of backwardness in each particular area. Column 1 gives the names of the electoral divisions; column 2, the number of backward children in each as ascertained by the methods just described; column 3, the proportion of children winning junior county scholarships; column 4, the proportion of educable mental defectives among the children living in the same districts. The figures for the backward are expressed as a percentage of the age-group examined; the figures for defectives and scholarship winners as the proportion of the total number of children aged 5 to 14 on the rolls of the ordinary schools.

The three sets of figures show a well-marked correspondence. Between the incidence of backwardness and of mental deficiency the correlation amounts to as much as ·93, and between the incidence of backwardness and the relative numbers of scholarship winners to — ·86.

The correlations are not perfect; and the imperfection is due to several discrepancies, sometimes quite large, between the original lists. It may be interesting to speculate on the causes of the more conspicuous. The largest are found between the proportions of backward children and of scholarship winners respectively. Here the outstanding cases are Mile End and Woolwich East. An explanation is not far to seek. We are comparing the two extremes in the distribution of educational ability. And the proportions above or below the borderlines chosen must depend, not only upon the general average of the area as a whole, but upon the range of individual variation within it. Evidently

[1] I have also excluded those whom I considered not to fall within the borderlines which I have adopted for the county as a whole, and have included the few mentally defective cases in ordinary schools who had not at that time been transferred to special schools.

the differences in range cannot after all be completely ignored. From the standpoint of intellectual capacity, Mile End is far more heterogeneous than most of the other divisions: it has a high proportion of dull or poverty-stricken individuals, who swell the numbers of the backward; but it also contains an unexpected number of extremely bright children, largely of Jewish origin, who win junior county scholarships. Woolwich, on the other hand, appears relatively homogeneous: it has comparatively few scholarship winners, but also comparatively few backward pupils. We cannot, then, always describe the intellectual quality of an area by its absolute average only, much less by either of the two extremes; we must also take into account the standard deviation, that is, the average range of individual variability as well as its average level.[1]

In the main, however, it is fair to say that, judged by the three criteria in front of us, the frequency of backwardness, the frequency of deficiency, and the paucity of scholarship ability, certain areas differ strikingly in general educational level from the county taken as a whole. These stand out plainly in the map compiled from the figures for backwardness (Fig. 1). Had we similar maps for the two other characteristics, very little difference would be discernible between the three. The map I have printed, therefore, may be regarded as indicating the geographical distribution of educational ability throughout the county.

A map such as this reveals clearly the type of neighbourhood in which provision for backward children is most urgently needed. It would appear that backward children

[1] The reader who is interested in the psychological geography of London will be able to examine such points for himself by making a closer study of the table. The most interesting differences are perhaps the following. Of the areas having a fairly high level of performance, Hampstead, Islington, E., and Kennington would appear, like Woolwich, E., to be relatively homogeneous, while St. Pancras, N., appears relatively heterogeneous. Of those having a moderate or low average, Peckham, Bethnal Green, and several other East End divisions, appear, like Mile End, to be relatively heterogeneous, while Holborn and Marylebone are fairly homogeneous. To confirm these further deductions, however, surveys carried out over a much longer period of time would be really essential.

are to be found in greatest numbers in the following parts :[1]

(i) The poorest and most overcrowded districts of the East End—Shoreditch, Limehouse, Poplar, both divisions of Bethnal Green ; to which may be added Whitechapel and Mile End, though here conditions are not so bad as is popularly supposed.

(ii) Similar districts, equally poor and still more insalubrious, situated to the south of the river—Lambeth (North), Southwark (all three divisions), Rotherhithe, Battersea (North), and perhaps Bermondsey (West).

(iii) Remnants of the Central London slum area in Finsbury and Holborn.

(iv) More isolated areas near the great railway termini: South-east and South-west St. Pancras, South and West Islington, North Kensington, and South Paddington.

(v) To these should be added certain outlying patches, often the result of slum-clearances elsewhere, in Peckham, Camberwell, and the extreme South.

Such a map and such figures, however, yield something more than temporary fingerposts for the local authority, in its inquiries about districts where the need for backward schools or classes is most pressing. They have a theoretical interest as well as a practical. Are there, we are tempted to ask, any general features, economic, social, or psychological, characterizing such backward districts and capable of explaining the educational weakness which the school population displays ?

In Table IV, side by side with the figures for backwardness, I have tabulated such accessible statistics as may throw some light upon this question.[2] Since comparable data are not available for the separate electoral divisions, I have grouped the figures under boroughs. The correlations between the figures for educational backwardness and the

[1] The student of local conditions in London will find it suggestive to compare also the map of juvenile delinquency given in the preceding volume in this series (*The Young Delinquent*, Fig. 4, see pp. 71 *et seq.*).

[2] I have to thank my former colleagues at the County Hall for providing me with much of the statistical data here recorded. The remainder of the figures have been taken from the annual volumes of *London Statistics* or the *New Survey of Life and Labour in London.*

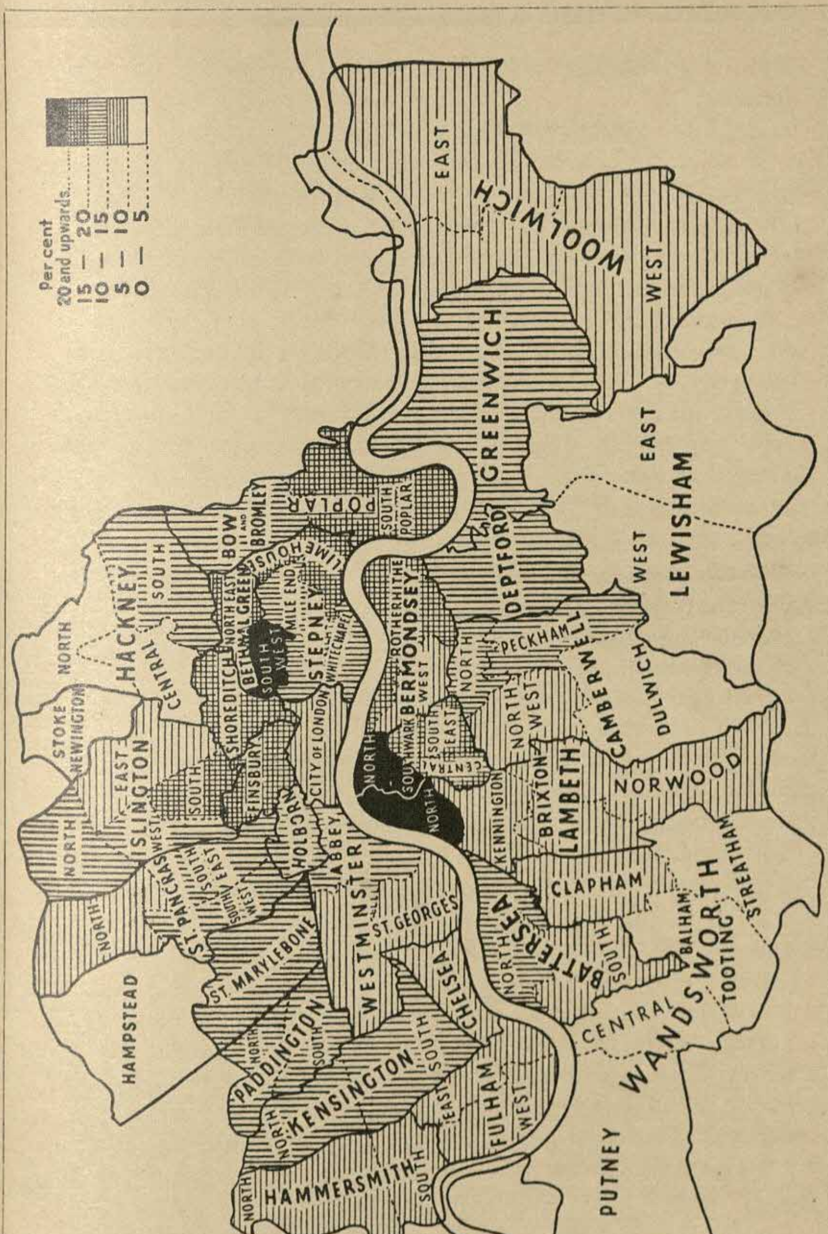


FIG. I.—DISTRIBUTION OF BACKWARDNESS IN LONDON

several statistical assessments are appended in the last line.

Column 1 gives the names of the divisions; column 2, the percentage of backward children calculated as before; column 3, the proportion of educable defectives living within each borough. The correlation between the two lists is much the same as that obtained on taking the smaller subdivisions, namely, ·91. In column 4 I add the proportions of children attending special schools situated within each borough. Here the correlation with backwardness sinks to ·26. As we have seen, however, such proportions indicate, not the amount of deficiency within each area, but rather the amount of accommodation provided. The actual amount of deficiency within a given neighbourhood is not the sole reason why a special school has been established there; indeed, when many of the special schools were first built, no means were available for making local surveys of the number of defective pupils resident in the different parts.

Column 5 gives the proportion of scholarship winners: the correlation with backwardness is now —·88—a slightly larger figure than before. Grouping divisions into boroughs has, we may suppose, partly neutralized the differences in heterogeneity that distinguished one electoral division from another. Some big discrepancies are still discernible. Boroughs, like St. Pancras, that are exceptionally mixed in social character, containing bad slum areas as well as good-class neighbourhoods, or, like the East End boroughs, somewhat mixed in racial composition, again show disproportionate numbers both of backward pupils and of scholarship winners.

Now let us turn to the social features. In order to ascertain more precisely the relation between poverty and backwardness at school, I have taken various figures that may serve to indicate the general economic character of the several districts. Probably the most trustworthy index is given by the proportion of inhabitants living below the poverty line.[1] This I have shown in column 7. The correlation

[1] In my investigation of delinquency in London (*The Young Delinquent*, p. 77), I used the figures obtained by Charles Booth in his earlier survey. The figures now given are those since published by the investigators for the *New*

between backwardness and poverty as thus assessed is ·73, distinctly higher than the correlation between poverty and juvenile delinquency (·69).[1] Other assessments that I have used are those for poor relief and for unemployment. The basis of these assessments, however, is a little unsatisfactory for the present purpose: the poor law unions, for example, are fewer in number and sometimes cut across the divisions between the boroughs. The correlation between backwardness and pauperism[2] is ·57; between backwardness and

Survey of Life and Labour in London (see especially Vol. III, p. 148, and Vol. VI, p. 132). The investigators have adopted practically the same definition of the poverty line as Charles Booth (see below, p. 119), making due allowance for the increase in the cost of living. The estimates were made in 1929, a little later than the date of the major portion of my own survey; but for the most part they differ but little from Booth's. Indeed, when large areas are taken, the general characteristics of the various parts of London seem to have been astonishingly constant for several generations.

[1] See *The Young Delinquent*, p. 77. It will be remembered that the figures for backwardness were based in part upon a grading of the various schools in the different districts. It is possible that those who assisted me in making such gradings were largely influenced, consciously or unconsciously, by their knowledge of the economic and hygienic conditions of the neighbourhood. Were it operative, any such influence might naturally tend to increase the correlation between the figures for backwardness and those for social characteristics. If the estimates for backwardness are based solely on the results of the junior county scholarship examination, the correlations are in the main not quite so high: for example, for economic grading, ·63; for general death-rate, ·69; for infantile death-rate, ·81; for overcrowding, ·73. In every case, however, the differences are less than three times their probable errors; and the correlations still remain remarkably high. It does not, of course, necessarily follow that the estimates as I have given them correlate too highly with social conditions. It is equally conceivable that the calculations based on the scholarship examination involve appreciable inaccuracies and so reduce the apparent correlation.

For certain parts of the county I made additional surveys of the distribution of educational abilities, first in 1913 and then again in 1932. Each of these surveys was incomplete; but, so far as it went, it showed that there was but little change in the distribution of backwardness from one decade to another. On working out correlations with the economic and social characteristics of the areas so reviewed, I find that the coefficients have on the whole tended steadily to decrease. This is consistent with an inference which might be drawn on other grounds—namely, that the progress of educational work throughout the county has come more and more to counteract the effects of deleterious conditions outside the school walls.

[2] Number of outdoor paupers in receipt of domiciliary relief.

TABLE

DISTRIBUTION OF BACKWARD CHILDREN COMPARED WITH SOCIAL

(1) Metropolitan Borough or City.	(2) Backward Children. (Percentage of Children attending Elementary Schools.)	(3) Mentally Defective Children. (Percentage of Children attending Elementary Schools.)	(4) Children attending Special Schools. (Percentage of Children attending Elementary Schools.)	(5) Junior County Scholarships Gained (per 1,000 Children attending Elementary Schools.)	(6) Juvenile Delinquency. (Percentage of Children on School Rolls.)	(7) Economic Grade. (Percentage of Population below Poverty Line.)
Shoreditch .	19·6	1·16	1·14	0·83	0·28	18·0
Bethnal Green .	18·4	1·14	1·14	1·13	0·14	17·8
Southwark .	17·3	1·11	1·11	1·15	0·18	13·5
Finsbury . .	16·7	1·04	0·86	0·74	0·42	13·2
Bermondsey .	14·8	1·01	0·71	1·17	0·23	17·5
Stepney . .	14·2	1·14	1·50	1·81	0·17	15·5
Poplar . .	13·8	0·93	0·77	1·78	0·12	24·1
Kensington .	13·6	1·02	0·67	1·32	0·12	7·9
Paddington .	12·2	0·92	0·49	1·71	0·14	6·2
Holborn . .	11·8	1·06	0·22	1·10	0·36	4·6
St. Pancras .	11·5	0·95	1·53	2·78	0·21	11·8
Islington . .	11·3	0·95	1·11	2·12	0·14	9·6
Battersea . .	11·1	0·90	1·05	2·44	0·16	8·1
Deptford . .	10·9	0·78	0·85	2·71	0·16	14·6
Lambeth . .	10·7	0·92	1·15	2·52	0·12	8·5
Marylebone .	10·4	0·93	0·53	1·27	0·15	4·6
Westminster .	10·2	0·77	0·32	1·82	0·15	4·2
Greenwich . .	10·1	0·75	0·93	1·92	0·11	11·8
Camberwell .	9·2	0·84	1·19	2·68	0·10	8·2
City . . .	9·0	0·59	0·00	2·00	0·05	8·9
Fulham . .	8·8	0·76	0·93	3·38	0·09	7·2
Hammersmith .	8·7	0·73	1·12	2·97	0·13	7·2
Chelsea . .	7·6	0·62	0·73	3·61	0·12	4·5
Woolwich . .	6·9	0·62	0·66	3·81	0·09	8·8
Hackney . .	6·7	0·73	0·77	4·25	0·08	7·4
Stoke Newington	4·3	0·55	1·01	4·14	0·00	5·4
Hampstead .	3·9	0·71	1·06	4·04	0·02	1·4
Wandsworth .	3·6	0·54	0·61	4·89	0·04	4·4
Lewisham . .	1·2	0·47	0·53	7·81	0·07	4·8
Correlation with Backwardness	—	0·914	0·257	−0·875	0·687	0·727

IV

CHARACTERISTICS OF THE METROPOLITAN BOROUGHS OF LONDON

(8) Poor Relief.	(9) Unemployment.	(10) Scheduling of School Children. (Percentage of Children of Elementary School Age.)	(11) Over-crowding. (Percentage of Population.)	(12) Size of Family.	(13) Birth-rate (per 1,000 Population).	(14) Death-rate (per 1,000 Population).	(15) Deaths under One Year (per 1,000 Births).
51·2	7·4	99·9	32·0	3·83	27·5	14·7	101·8
24·8	6·2	98·9	27·8	3·79	24·7	13·3	95·5
32·2	6·2	99·7	23·5	3·54	24·4	14·3	85·4
21·5	5·2	100·0	34·0	3·54	24·6	14·8	83·3
46·1	9·3	99·8	23·2	3·67	25·9	14·6	92·6
19·5	8·0	99·5	29·0	3·84	23·6	12·9	85·5
82·6	8·7	98·7	21·2	3·74	26·1	12·8	81·3
9·5	3·2	89·7	16·7	3·32	17·6	13·0	91·6
14·8	3·1	90·5	15·4	3·08	18·4	12·4	79·7
16·3	5·3	92·4	19·8	2·94	14·6	12·7	72·7
20·4	3·4	94·2	22·4	3·13	21·0	13·4	74·6
25·6	4·3	95·8	19·4	3·30	21·8	12·8	76·6
43·0	3·5	95·3	12·4	3·47	20·9	12·0	75·2
39·4	6·6	98·6	12·8	3·50	22·1	12·5	80·3
20·6	3·7	90·5	12·7	3·35	20·5	12·7	74·1
7·8	3·0	90·9	17·9	3·09	15·9	12·9	69·3
5·3	2·5	92·2	10·1	3·07	12·8	11·8	69·7
16·3	4·0	87·7	13·8	3·83	20·7	12·0	68·0
33·8	3·7	93·6	12·8	3·54	21·2	12·3	74·3
3·5	4·2	82·5	6·6	3·02	9·6	12·8	79·4
13·8	3·1	94·9	13·1	3·38	19·8	11·4	75·7
17·1	2·7	94·8	13·8	3·43	20·3	12·0	75·2
12·5	3·0	94·3	13·7	3·22	16·2	13·0	66·6
27·2	4·3	92·3	7·8	3·35	20·3	10·8	62·0
18·3	4·2	94·0	11·5	3·39	20·3	11·7	73·4
7·6	4·0	88·9	8·1	3·40	18·0	12·2	67·1
2·5	1·6	64·5	6·5	3·32	14·5	11·0	56·6
8·2	2·0	82·9	6·8	3·50	16·3	10·8	64·3
22·7	2·5	84·7	4·7	3·47	18·2	10·7	59·3
0·568	0·676	0·669	0·890	0·348	0·623	0·873	0·934

unemployment[1] ·68. These figures, however, depict the economic character of a borough only in terms of the extremely poor; and, as we have seen more than once, it is not altogether satisfactory to judge an area solely by an extreme manifestation. A more general indication may be sought by considering the proportionate number of children scheduled for school purposes. The scheduling is carried out on the basis of a rough economic assessment; and might be taken as indicating, not so much the prevalence of extremely poor families as the relative absence of well-to-do. The figures are shown in column 10; their correlation with backwardness is ·67.

Backwardness and poverty, therefore, go largely hand in hand. Accordingly, we shall expect to find backwardness correlated with those further social features that predominate in the poorer districts. With overcrowding,[2] for example, the correlation is ·89; with juvenile delinquency, ·69. The eugenist will be more interested in the connexion between intellectual inferiority and what are sometimes called 'vital statistics.' With the general death-rate the correlation is ·87; with the birth-rate ·62; and with the average size of the family ·35. The high birth-rate must be to some extent neutralized by the high death-rate; but nevertheless it would appear that the areas where the dull are most numerous are the areas where the population is multiplying most rapidly. The natural inference—namely, that this greater multiplication is itself largely due to the greater multiplication of the dull—is confirmed by figures directly obtained from the groups of normal and backward children here studied: the correlation between the intelligence of a child and the size of the family to which he belongs is − ·19; the correlation

[1] Number of unemployed on the register of labour exchanges, reduced to rate per 1,000 population.

The percentages found in the various boroughs for these different characteristics agree fairly well in relative magnitude with the percentages given for poverty; for further details see *The Young Delinquent*, Table V. For a discussion of the effect of the differential birthrate on the intellectual level of the population, see Burt, *Intelligence and Fertility* (Hamish Hamilton, 1946).

[2] Percentage (of total population in private families) living more than two in a room in tenements of all sizes.

between educational attainments and size of family is — ·22. The average number of children in families containing at least one backward child is 4·6; in families containing at least one scholarship winner it is 3·3. The ascertainment of such relationships, however, was not a primary object of my research; and therefore some caution must be observed in drawing deductions from the figures.

Of all the characteristics distinguishing the different boroughs, the one that yields the highest correlation with educational backwardness is infantile mortality.[1] Here the

[1] Table IV, column 15, gives the average deaths under one year per thousand births during the years in which my survey was mainly carried out (1920–23). It might, however, be urged that, if the chief cause of the correlation between backwardness and the infantile death-rate lies in the fact that the dull and backward consist largely of children whose health was undermined during infancy, I should take the death-rate for those years in which the backward children were themselves infants under the age of one. The correlation is then ·81: but the difference is less than its probable error. Or again it might have been considered better to take the figures for death-rate, and for social and economic conditions generally, over the whole period during which the children were growing up. With the present survey this would have been difficult. For the period during and immediately after the war, trustworthy figures are not always available; and, further, exceptional conditions were then operative in many of the districts. As a rule, I find that the correlations of backwardness with the infantile death-rate, general death-rate, and the like, are highest when figures are taken for the years during which the surveys are carried out. This indicates, what might naturally be assumed on other grounds, that such correlations represent a somewhat complex set of influences. Recent ill-health, for example, as well as early ill-health, may tend to increase a child's backwardness. Teachers often declare that, when there has been a good deal of illness in their neighbourhood, the general level of the school work often suffers for several months: an epidemic of influenza, a spell of severe weather, or a wave of depression in local industries or trades, may send up the infantile death-rate in certain boroughs, and at the same time temporarily impair the vitality of the older children so that their attainments for a while deteriorate The correlation between the infantile death-rates from year to year varies between ·70 and ·95; but after a local epidemic it may drop to ·60 or less.

It may be of interest to inquire how far other educational characteristics correlate with economic or hygienic features. The answer is that the correlations seem to be of much the same order, but if anything (as might be anticipated) a little smaller: *e.g.* mental deficiency and economic grade, ·58; mental deficiency and infantile death-rate, ·82; junior county scholarships and economic grade, — ·63; junior county scholarships and infantile death-rate, — ·75.

coefficient of correlation rises to ·93. There is an obvious inference. The various agencies which increase the death-rate during infancy presumably tend at the same time to lower the physical and mental vitality of the survivors, even when insufficient to cause their early death.[1]

This, of course, is not the only explanation that could be suggested. But it is abundantly supported by detailed evidence from my individual case-histories. In passing, however, I must emphasize that the injurious agencies are by no means exclusively physical or economic. Lack of space, of sunshine, of fresh air, of adequate and proper food, exposure to infection and to climatic changes, inability to procure medical attention, an initial weakness attributable in part to weakness inherited from the parents and in part to the mother's own ill-health or malnutrition during pregnancy—all this no doubt may help to destroy many young lives among the poor, and leave others permanently impaired. But the most frequent and conspicuous feature is the want of proper maternal care—in a word, the inefficiency of the mother. Often this itself is a result of her poverty and consequent poor health; occasionally it is a result of her erratic temperament; but in a large number of cases, perhaps in most, it seemed the inevitable outcome of her own subnormal intelligence. But whatever may be the remoter factors at work, there can be little question that ill-health during early infancy, before ever the

[1] The plain man willingly accepts this explanation. The scientist will be less ready to admit it. From a biological standpoint it might be argued that, in those areas where the death-rate is high, a kind of natural selection must be operative, tending to raise rather than to lower the average vitality of the survivors. If the weaklings are killed off, those who are left should be children with higher resistive powers and therefore presumably with strong physical and mental constitutions. Consequently, in better-class areas where weaklings are kept alive, the average level of the older children should be worse and not better. There is, moreover, some evidence in favour of this paradox: taking members of the same generation, the correlation between the death-rate in any given year and the death-rate in the years succeeding is actually negative. (Compare, for example, Pearson and Elderton, 'Further Evidence of Natural Selection in Man,' *Biometrika*, X, 1915.) The problem, therefore, is a little more complex than might at first be supposed. I have no space to discuss the issue in full; but I believe the two points of view are by no means irreconcilable.

child comes to school, is one of the most important causes of backwardness during the school period itself.

Let us now sum up the inferences suggested by the figures in the table. The coefficients plainly imply that it is in the poor, overcrowded, insanitary households, where families are large, where the children are dependent solely on the State for their education, and where the parents are largely dependent on charity or relief for their own maintenance, where both birth-rates and infantile death-rates are high, and the infant's health is undermined from the earliest days of its life, that educational backwardness is most prevalent.

It would appear, then, that there is a close and local association between the material handicaps of families living in particular districts and the backwardness of the school population. Yet, to conclude off-hand that in each individual case poverty is the main cause of dullness or incompetence would be neither just nor logical. A bare smattering of biography is sufficient to refute that simple induction. Bunyan, the tinker, Faraday, the blacksmith's son, Sextus V, the child of a shepherd, Adrian VI, the son of a bargee, Burns, Cook, Giotto, all sons of peasants, d'Alembert, the foundling picked up one Christmas night on the snowy steps of a Parisian church, Romney, Opie, Inigo Jones and Abraham Lincoln, each the son of a carpenter—these and many like them have risen to the loftiest intellectual eminence from the lowliest social spheres. The poorest tenements of London contain many youthful geniuses, some of whom win—more of whom merit but fail to win—a free place or scholarship at a secondary school or college.

Stupidity, therefore, is not the inevitable result of poverty, though poverty seems its commonest concomitant; and to discover more precisely how the two interact, an analysis, not of districts, but of individual cases, will be required. Is it the lowest stocks and the dullest families that gravitate to the slums, and there, by their poor intelligence, perpetuate and even aggravate the squalor that they find? Or do the under-feeding, the over-crowding, and the many daily deprivations, tend to devitalize minds that originally were normal? And if they devitalize

some minds, how is it that they leave others apparently unimpaired ?

Causal Analysis of Sample Cases.—To answer these further questions, the rough results of the broad survey I have just described must be supplemented by a more intensive research. Accordingly, in the hope of bringing to light the more immediate causes of backwardness, and the precise ways in which they operate, I have taken 400 consecutive cases of backwardness—200 boys and 200 girls—and endeavoured to make a systematic study of each one. The inquiries followed the several lines that I have indicated in the preceding chapter : by means of standardized tests, each child was systematically tested for intelligence, for school attainments, and in most instances for special intellectual capacities. All available information was collected in regard to his physical and medical condition both at the time of the inquiry and throughout his past life. Home circumstances and family history were investigated ; special reports were obtained upon his school progress and his general conduct. Temperamental as well as intellectual characteristics were recorded in every case. The whole of the data was then subjected to a close statistical analysis.

With a view to checking the inferences that might be drawn, a second batch of normal children were studied along precisely the same lines. Simply to enumerate the conditions found in a backward group alone would of itself prove little or nothing. Yet in most investigations this is all that is done. To learn that 30 per cent. of the cases are under-fed, or that 20 per cent. are employed during out-of-school hours, cannot demonstrate that under-feeding or street-trading necessarily makes a child backward at his lessons. We must inquire whether normal children do not often labour under equally heavy handicaps—whether they may not suffer quite as frequently from lack of food or excessive fatigue, without dropping behind in their school work. A control group, therefore, is indispensable. A parallel investigation must be attempted into the conditions actually obtaining among the general mass of school pupils.

To this end I have adopted the following plan. Wherever

I have examined a backward child for the purpose of this research, I have at the same time made an identical study of a second child of the same sex, of the same age, and attending the same school, but known to be quite equal to the normal standard in educational attainments and progress. Apart from these specific requirements, the second child has been chosen by chance. My method has been to copy from the register the names of all children born in the same month as the backward child, and then to ask the head teacher to cross off from this list all who were brighter or duller than the average. When, as usually happened, more than one name was still left, the final selection of the child to be studied was decided by drawing lots. The control-case, ultimately picked out in this fashion, was then tested and examined in precisely the same way as his backward twin.[1] In a few instances it eventually proved that the information collected for one of the backward children or (more frequently) for a child in the control group was either untrustworthy or else incomplete. In such cases, both members of the pair have been omitted. The result is that my final figures are based on 193 backward boys and 198 backward girls, with corresponding numbers in the control groups, instead of upon 200 for each sex.

As a further check on the results, reference will be made to a similar but shorter inquiry carried out in Birmingham. In this investigation there were 196 in the backward group, and 197 in the control group. In the Birmingham control group, however, only 90 proved equal to the average stan-

[1] A short preliminary account of this inquiry in its early stages was published in my report to the London County Council on *The Distribution and Relations of Educational Abilities*, pp. 36 *et seq.* The larger portion of the work was done during the period when I was a half-time officer for the Council, and therefore had free access to the elementary schools and more leisure for research.

From the outset the investigation was planned as a 'longitudinal study'; and I have since been able to keep in touch with the vast majority of the cases over periods ranging from 10 to 30 years. The results, as will be seen, have provided a valuable check on the initial estimates. In all this I have been greatly helped by voluntary assistants, particularly Miss V. G. Pelling, Miss H. R. Berners, Miss L. G. Martin, and Mr. T. N. Butler, who have assisted me in visiting many of the homes.

dard for their age, the remainder being slightly below, though not definitely retarded in the technical sense. Here the psychological examination was carried out by myself, and the special medical examination by Dr. B. R. Lloyd.[1] The figures for each group—the backward group and the control-group—were separately calculated; and the comparison may be used to corroborate the results obtained in London.

In addition, both at Birmingham and at London a sample group of mentally defective cases were examined along similar lines. If we can assume that most mentally defective children are, in fact, merely extreme specimens of ordinary dullness, these further findings may serve at certain points to corroborate our general conclusions. The certified defective, however, is really a problem in himself; and I shall therefore only refer to these additional results in passing, as I deal here and there with certain special points.[2]

Results.—The results may be most concisely presented in the form of a parallel tabulation, with the percentages for the normal and the backward exhibited side by side. Tables V, VII, XIII, XXI, XXII, and XXIX give the figures for the London cases, and Tables VI, XIV, XXI, and XXX those for Birmingham. The simplest way to detect differences would be to subtract the percentage for

[1] See *Report of an Investigation upon Backward Children in Birmingham* (1920), Table IV.

[2] The most interesting point of comparison is the incidence of physical or medical defects among the defectives as compared with the dull and the normal school population. At London the data were collected during my surveys of the special m.d. schools; 200 boys and 200 girls were systematically examined; and the work was intended as part of a research upon the educable defective which I hope to publish in a later volume. At Birmingham, Dr. Lloyd's study of the defective group tends to show that his cases included a higher proportion of pathological types than would be found in London special schools. In London the social and economic circumstances of the defective would require a separate investigation, since they were not precisely parallel with those of the control group. Hence it would not be fair to throw the defective and the backward children together and treat them as a sample of the so-called 'retarded' group. Indeed, this further inquiry demonstrates that the defectives of the special schools form an even more heterogeneous assortment than the dull and backward; and thus call for distinct psychological study.

the normal from that for the backward. This, however, is a somewhat crude and unreliable method of comparison: and a more effective method of assessing the importance of each factor is to deduce a single index figure—a coefficient of correlation. Such coefficients I have appended in the last column for every condition studied.[1]

It will at once be seen that the inquiries reveal no single or constant difference among the conditions observed, sharply dividing the backward from the normal. The inference seems plain. Educational backwardness has no one specific cause. It is merely a superficial symptom, a complex resultant attributable to a variety, and usually to a multiplicity, of alternative and converging influences. It is this plurality of causes that stultifies our simple rough-and-ready remedies. It is not the last straw, but the accumulation of straws, that breaks the camel's back. We must unload every one.

[1] A coefficient of correlation is a fraction ranging from − 1 through 0 to + 1, intended to measure the amount of agreement—of concomitant variation, as the mathematician would say—between two things. 0 indicates no agreement; + 1 positive and perfect correspondence; − 1 complete negative correspondence, that is to say, the regular absence or decrease of one factor when the other factor is present or increases. With such data as the following, the best method of calculating such correspondences is still an open question, which, indeed, has never been completely thrashed out.

My own view is that comparisons based on twofold classifications ('backward' and 'not backward,' 'defective' and 'not defective,' and the like) can lead only to provisional inferences, broad, tentative, and often suggestive, but rarely if ever conclusive or exact. Nevertheless, in the field of psychology with which we are at present concerned this is likely to be the form which the obtainable data will mainly take: intensive inquiries based on a finer grading will probably be few and far between. Hence, I have thought it advisable to examine in some detail the various statistical devices that are available and to compare their various merits; a full discussion will be found in Appendix III.

Here it may be sufficient to note that the coefficients of correlation have little value unless they exceed ·12 in the London investigation and ·15 in the Birmingham investigation—or thereabouts; a significant coefficient varies slightly according to the percentages on which it is based. A significant difference between the percentages themselves will vary still more widely according to the magnitude of the percentages. There are various ways of determining such significant differences. Here, however, in practice they lead to much the same result. A table of significant differences will be found in Appendix III.

In the causation of any abnormal state of mind, this variety and this complexity in the factors at work appears to be an all but universal rule. Nevertheless, here as elsewhere, certain special influences—in one child this factor, in another child that—can often be discerned as being of outstanding importance. Hence it becomes possible to sift and sort the majority of the cases into broad classes or types according to the particular cause that seems to be dominant in each.

What, then, are the conditions most frequently found? And which are the factors that tend to predominate? To begin with, they divide themselves into two main groups: first, causes that are pre-natal, and therefore, as a rule, irreparable; secondly, causes that are post-natal, and therefore, as a rule, remediable. So far as the distinction can be applied to individual instances, we shall find that, in well over half the cases, the backwardness seems due chiefly to intrinsic mental factors; here, therefore, it is primary, innate, and to that extent beyond all hope of cure: in rather less than half, the principal cause is apparently not mental at all; the child's lack of progress is an incidental outcome of something quite extrinsic—some physical, social, or administrative difficulty; here, therefore, the backwardness is secondary or acquired, and, in theory at any rate, curable.[1] All through, however, most of the cases are cases of mixed causation: though one condition be singled out as paramount, others undoubtedly contribute. A real inherent inferiority of mind—sometimes slight, sometimes profound—sometimes general, sometimes specific—is aggravated by two or three superadded difficulties, poverty at home, weakness of health, inappropriate teaching, or the like; and the final upshot of these interacting factors is a grave and cumulative retardation in the child's educational progress.

Let us, then, examine the various causes one by one. We may take the extrinsic or environmental factors first, for these, as a rule, are the most obvious to discover and the easiest to remove. The child's environment we may view as consisting, on the one hand, of his school, and, on the other, of his home—including under the vague term home

[1] The evidence for this conclusion will be discussed more fully at the close of my review: see below, Chapter XVI.

the sum total of those manifold conditions for which his parents are directly or indirectly responsible. It will be natural to begin with the school, since backwardness, as we have defined it, declares itself primarily by failure in school work. The data, so far as they can be reduced to figures, are given in Tables V and VI.

A. School Conditions

1. *Irregular Attendance.*—The most direct reason for a lack of school attainments is absence from school itself. In London 11 per cent. of the backward children owed their backwardness mainly or in part to prolonged or frequent non-attendance (Table V). Compared with the small amount reported among the normal children, this figure is significantly high. The contrast, indeed, is one of the most striking in the whole set of tables: of the normal children barely one in fifty has been irregular in his attendance; of the backward children as many as one in ten. In some cases the child had not started school until six or seven years of age; in others he had been absent for long periods together; most commonly of all, he had been continually away for short but recurrent spells.

In Birmingham the percentage was larger still (Table VI). Here marked irregularities of attendance were noted among nearly one-third of the backward children: no other single factor was so frequently found. Judged by the average percentage of attendance registered during the current year, whereas the normal child had been absent for one day out of sixteen, the backward child had been absent for one day out of seven; over one-fifth of the backward had made less than 80 per cent. of the possible attendances.

Of this irregular attendance, much, no doubt, is excusable —due to the child's own ailments, or to his exclusion on account of infection in the house or family. A sequence of three or four childish fevers, an obstinate complaint like ringworm or vermin in the hair, some minor surgical trouble entailing repeated visits to the hospital, these may break up the continuity of the child's schooling, and yet, since they stamp no visible mark upon his general health or character, are liable to slip from the teacher's mind. Then

one day the school wakes up to the fact that the child is surprisingly backward, and nobody recollects the reason. Only when the parent is cross-questioned, or the records from the child's previous class or department are turned up, does the true cause spring to light.

TABLE V. SCHOOL CONDITIONS (LONDON)

Percentage of Normal and Backward Children with Records of Irregular Attendance, or Inefficient Teaching or School Organization.

	Normal.			Backward.			Correlation with Backwardness.
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	
Irregular attendance during current year (below 80 per cent.)	1·0	2·0	1·5	3·6	4·6	4·1	·23
Irregular attendance in the past . .	1·6	2·5	2·1	12·4	10·6	11·5	·45
Inefficient teaching .	1·6	2·0	1·8	3·1	2·0	2·6	·08
Delayed promotion or change of school .	2·6	2·5	2·6	6·2	4·0	5·1	·10

TABLE VI. SCHOOL CONDITIONS (BIRMINGHAM)

Percentage of Normal and Backward Children with Records of Irregular Attendance, or Inefficient Teaching or School Organization.

	Normal.	Backward.	Correlation with Backwardness.
Irregular attendance during current year (below 80 per cent.) .	2·6	21·4	·59
Irregular attendance in the past	5·1	31·1	·58
Inefficient teaching	0·0	4·6	[1·00]
Delayed promotion or change of school	1·0	7·1	·46

Much of the irregularity, however, is quite unjustifiable, and must be laid at the door of parental connivance or neglect. Most troublesome of all, perhaps, yet largely preventable, are the consequences of perpetual migration. In huge towns where industries are mixed, and where there is a large mass of floating labour and a great deal of casual fluctuating work, many families are for ever on the move :

the child disappears from his former neighbourhood; there is a long delay before he can be followed up; and it is only after several weeks that he is entered as a new pupil at a fresh school. A few more months pass by; and the family flits again. Under such conditions, even a sharp and intelligent youngster may grow up an utter ignoramus.

In certain parts of London this habit of migration is exceedingly common; and here irregular school attendance is more prevalent than elsewhere. Just before the war, as part of an inquiry upon backwardness, the attendance figures were analysed for the entire county by the chief inspector of schools. In over two hundred departments it was found that 'the average length of time spent in a senior school was only 2½ years as compared with a possible 6 or 7.'[1] But, on the whole, throughout the present century non-attendance has steadily diminished. In 1900 as many as 28,836 summonses were issued in London for the purpose of enforcing school attendance; in 1929 only 2,966, roughly one-tenth of the former figure; and during the thirty intervening years the decline was fairly constant, year by year. Non-attendance, therefore, is playing a diminishing part in the production of backwardness.[2]

2. *Inefficient Teaching*.—Of all the more obvious causes of backwardness, the one most frequently canvassed in the

[1] See *London County Council: Scheme of the Local Education Authority*, 1920, Sect. XI, 'Development of Backward Classes,' p. 68.

[2] Averaging the figures for successive periods of five years, the number of summonses, expressed as a percentage of the number of children on the school rolls, is as follows: 1900–4, 3·5 per cent.; 1905–9, 2·0 per cent.; 1910–14, 1·2 per cent.; 1915–19, 1·6 per cent.; 1920–4, 0·9 per cent.; 1925–9, 0·6 per cent. Except for the last years of the war, the diminution is continuous. No doubt changes in the policy or methods of the attendance officer may in part account for the decrease in actual legal proceedings: but there can be little question that the figures themselves reflect the enormous reduction in non-attendance that has been effected during the past thirty years.

If the records and reports of teachers can be trusted for the comparison, it would seem that, although the total amount of inattendance was lower in London, a larger proportion of it was not warranted by any legitimate ground or excuse: in Birmingham most of the irregular attendance in the backward group was attributed to ill-health.

past has been the inefficiency of the teacher. Strangely enough, in the cases covered by my own investigations, bad teaching was very rarely to blame.

Both the wars, with the continual changes in personnel which they involved, furnished many unintentional experiments on the effects of a change of teachers. During the first world war more particularly most of the larger areas reported a temporary increase in the number of backward children. But several factors contributed; and the dislocation of staff, like all the other disturbances, bore most heavily upon the dull or unstable children—upon those who had less adaptability, less initiative, and a smaller measure of self-control.

Arithmetic, a subject which, more than any other, demands continuity of teaching, generally suffered most; and in particular it was often alleged that arithmetic rapidly deteriorated in several of the departments where women teachers had been introduced. Yet, it was by no means the new and freer methods of the women, nor yet the superior competence and stricter control of their male predecessors, that seemed exclusively accountable for the result; often it was simply the change itself. In one of the boys' schools which I was asked to investigate, stress had previously been laid on mechanical accuracy in daily work and on military promptitude in behaviour; here the women, with their broader and more tolerant outlook, failed, at any rate at the outset, both in maintaining the advantages of discipline and in introducing the benefits of liberty. At first there was a reaction and a set-back. The percentage of backward cases doubled. Yet this was only transitory, and was very soon reversed. In an inspection, made three years later, the amount of backwardness had dropped to less than half the original figure. The head-master himself, though presumably possessing the natural prejudices of the male, very generously ascribed the ultimate improvement 'to the greater personal interest that the feminine sex seems to feel for the individual as an individual, and to their special sympathy for the weak.'

Generally speaking, the number of backward cases attributable to bad teaching appears more and more on the

decline. At one time it was no unusual custom to reserve the brightest and best-trained teachers for the abler pupils in the higher standards, and to consign the big, dull. unprogressive lads to a sort of human lumber-room under the oldest and least stimulating master. Such a practice may not, perhaps, actually produce backwardness, since the backwardness is already there; but it does nothing to remove and much to augment it. This, however, is a policy that is certainly on the wane. Nowadays, with an enterprising head teacher the opposite line is more likely to be pursued; and more than one school could be named where the most efficient and up-to-date teaching is to be seen in the backward class.

To complain of bad teaching is scarcely helpful unless one specifies where the teaching is at fault. It is fair to say that, on the whole, the middle stages of elementary education have not received the same amount of attention as has been bestowed on the infants' school or on the highest classes of all. The subjects and the mode of approach are still old-fashioned. In the lowest standards of the upper departments, the most primitive methods still frequently persist.[1] Here it is the teacher rather than the child who is backward. The effects are perhaps most harmful, as they are certainly most evident, in the teaching of reading. The consequences may then be widespread: the dull youngster may be kept back, not in reading alone, but in all the subjects that depend upon it. In the higher classes, bad teaching is more likely to be discernible in some particular subject in which the teacher himself is weak: arithmetic, as taught to older and duller girls, is perhaps the subject most conspicuously affected in this way.

As a general rule, however, the point at which the teacher is most open to criticism consists, not in the inefficiency of his methods as judged by ordinary requirements, but rather in his failure to adapt his methods to the peculiar needs of

[1] The report and recommendations of the Consultative Committee of the Board of Education on the problems of *The Primary School* have already had an excellent influence in drawing attention to the need for improvement both in curriculum and in teaching methods at this stage; but there is an admirable field for experimental work in the reorganized junior schools.

the backward. At times his disregard goes even farther. He entirely omits to find out which of his pupils are backward and who stand in need of special treatment. The dullard is left marking time in a low class ; his dullness gets accepted like an axiom : and presently the fact that he is a couple of years above the average age is altogether forgotten. Sometimes, indeed, the sheer size of the lad excites a startled comment on his puny attainments. But still no one attempts to search out a cause. Half unconsciously it is taken for granted that some incurable stupidity or some inherent obstinacy on the part of the child himself must be the sole and sufficient explanation. Nothing is done. And the child leaves school unable to write the simplest letter or to work out the most commonplace sum.

As we shall see later on, this is often the history of the child who is specifically backward in reading. Having been absent perhaps for six months from the infants' department, he is promoted to the upper department while still unable to understand a single line of print ; there the teacher implicitly assumes that the child has never learnt to read because he cannot ; and no fresh effort is made.

In the majority of instances, however, the problem is less straightforward. The teacher labours in vain, because he has never realized that the whole type of instruction requires to be radically changed. Once the necessity has been explained to him, he is ready to do his best. But perhaps the most difficult point to bring home is that there is no single method appropriate to the backward child as such. The essential need is a teacher with an experimental outlook and adaptable turn of mind. What particular changes should be made will depend in every instance on the underlying causes of the trouble : hence the main key to success is to vary and modify the teaching until it fits the individual child.

But the teacher must not be expected to shoulder all the blame. The investigation of contributing factors is a long and complicated process, requiring time, personal attention, and a special psychological technique. The psychologist is only just beginning to supply the necessary technical methods ; and it is not every head teacher or administrative

authority that can spare the assistant time and freedom for first-hand studies in the classroom, or permit the classes themselves to be small enough for an experimental attitude and for individual work.

In most of the cases of backwardness where the fault lies mainly with the school, the school organization rather than the teacher seems at bottom responsible. There is, in particular, one factor that is met with far more frequently than inefficient teaching—namely, delayed or ill-timed promotion, whether from one department to another, or from one class to a second within the same department.[1] Sometimes the child is promoted too slowly. Sometimes he is promoted to a standard for which he is not yet ripe. Most of all, the discontinuity of methods between the infants' department and the senior department, or between two successive schools, is answerable for the sudden lack of progress so common in boys and girls towards the age of 8 or 9. In one department the child may have been taught to read on 'word-whole' or 'look-and-say' principles; in another he has to start again on purely phonic or alphabetic lines. At his first school he may have been taught subtraction by the old-fashioned process of equal additions; at his new school he is required to re-learn it by the new-fashioned device of decomposition. Hence, to be enrolled in a fresh school often means being sent back to a lower class to learn the proper procedure, just as a patient with a badly set limb is sometimes sent once again into the hospital to have the bone re-broken; and so the child's whole educational development is abruptly thrown out of gear by what at first sight seems a negligible change. Teachers themselves have come to realize this source of failure; and of late have largely corrected it by adopting more flexible methods and by seeking a freer interchange of views.

When all is said, however, the criticisms that I have just ventured to pass apply only to a small fraction of the cases. Under normal conditions, defects of teaching and of school organization account for less than one case in twenty. And it is encouraging to note that these causes have become rarer and rarer in more recent surveys as compared with those

[1] See again Tables V and VI.

carried out ten or twelve years ago. It is clear, therefore, that in the main the causes of educational backwardness must be sought outside the school itself.

B. Home Conditions

Two months in every year, two days in every week, and all except five hours out of every twenty-four, are spent by the child not at school but somewhere else—at home, in the street, or wherever he takes his recreation. Hence much that is done in the classroom during the working day may be undone during the evenings and weekends when the child is at large. It is not enough, therefore, to examine the backward child in the schoolroom and talk over his failings with the teacher ; it is equally essential to study the conditions of his life outside. And, if our survey is to miss no important cause of backwardness, we must pass on to inquire how far the backward and the normal differ in their out-of-school environment.

1. *Poverty*.—The factors on which teachers themselves are wont to lay most stress are those that arise within the child's own home. Nor can it be denied that in this direction the teacher has often to struggle against grave and depressing hindrances. The difficulty is greatest in the slum-areas. As we have already seen, it is in the poorer districts that the backward are most numerous ; and the social reformer, assuming, as he generally does, that all are born with equal gifts, infers that it is the heavy hand of penury that manufactures dullards and dunces out of normal boys and girls. Let us examine, therefore, with closer detail and precision, the facts that are brought to light by the home inquiries in the case of our two selected groups. I shall begin with economic conditions first, since these are most easily defined and assessed.

The word 'poverty,' though constantly employed in these discussions, is in itself somewhat vague and ambiguous. There is the frugal poverty that scrapes to find the rent ; there is the hungry poverty that never knows where to look for the next meal ; there is the respectable poverty that sacrifices necessities to appearance. In this research, as in my previous study of delinquency, I have followed Mr.

Seebohm Rowntree's definition.[1] Poverty I have taken to mean earnings insufficient for the full maintenance of bodily health in all the members of the family. By estimating the expenditure needed for food, rent, clothing, and fuel, with a family of a stated size, it is possible to calculate for any given year a minimum standard in the cost of living. This minimum may be termed the poverty line: it marks the margin of a bare subsistence.[2]

Among my backward cases in London, I find that over 20 per cent. fell definitely below this standard: about one child in five was thus in want of the common necessities of life. The percentage is considerably higher among the backward girls than among the backward boys: upon the frailer sex, domestic duties and unhealthy conditions of existence appear to tell more heavily. In the control group the number below the poverty line amounts to 15 per cent. The difference is significant, but not large. It would yield a correlation between backwardness and extreme poverty of only ·10. Plainly, to be brought up in the poorest of homes, and yet to achieve normal progress at school, are by no means incompatible.

There is, however, a special reason why the amount of poverty in the control group should be so high. It will be remembered that each normal child, being paired with a backward child, had to be chosen from the same school as the latter. The schools containing backward children are usually schools in poor neighbourhoods. It follows that there is a fair chance that the normal child so picked will be

[1] *Poverty*, 1901, chapter iv, 'The Poverty Line.'

[2] My poverty line cuts off approximately the classes labelled by Charles Booth 'A' and 'B': 'A' comprises 'the lowest class of occasional labourers: loafers, street-sellers, the destitute, the semi-criminal'; and 'B' includes 'casual labour; irregular earnings; chronic want.' (See his *Life and Labour in London*, vol. i, 1889, pp. 33 *et seq.*) These two classes together he terms the 'very poor'; he calculates that 12·5 per cent. fall within that category. His next two classes, 'C' (chiefly 'seasonal labour and intermittent earnings') and 'D' (chiefly 'small but constant earnings; unskilled, but regular labour'), are grouped together as 'poor.' Since the last war economic conditions in London, as throughout the country, have greatly improved; yet the amount of dullness and deficiency remains almost unchanged, and the amount of remediable backwardness has been but slightly reduced.

almost as poverty-stricken as his backward fellow. If we take figures for the whole of London, the percentage would be far lower. I estimate that barely 8 per cent. of the school population is below the poverty line as above defined. This would raise the correlation between backwardness and extreme poverty from ·10 to ·30.

Among the backward another 38 per cent. came from homes that were moderately poor. Accordingly, if we take these figures as representative of the whole county, we may conclude that well over half the children in London who are dull and backward come from poor homes. On the other hand, barely one in ten come from homes that are well-to-do. The detailed figures for the main economic groups are given in the table below.[1]

TABLE VII. SOCIAL CONDITIONS (LONDON)

Percentages of Normal and Backward Children falling into the Various Economic Categories (the averages in column 3 are for all London).

Home Circumstances.	Control Group.			Backward.			Correlation of Home Circumstances with Backwardness.
	Boys.	Girls.	Av.[2]	Boys.	Girls.	Av.	
Very Poor (A & B) .	14·0	16·2	8·4	16·1	24·7	20·4	·30
Poor (C & D) . .	33·1	34·8	22·3	37·3	39·9	38·6	·24
Comfortable (E & F)	39·4	37·4	51·5	35·2	27·3	31·2	— ·26
Well-to-do (G & H)	13·5	11·6	17·8	11·4	8·1	9·7	— ·18

If, employing the tetrachoric method,[2] we calculate coefficients of correlation merely from the percentages observed among the backward and among the general population, we find that the correlation between backwardness and economic circumstances averages about ·25, being highest in the case of extreme poverty. Here, how-

[1] Classified according to father's occupation the proportions are as follows: professional, 44% ; clerical, 9% ; skilled, 14% ; semi-skilled, 28% ; unskilled or casual, 45%. Since for innate ability the correlation between parent and child is only 0·5, a large proportion of children must always fail to have the ability needed to remain in the father's occupational class. This is a *genetic* effect. Hence in every century there must have been a good deal of social mobility, down as well as up.

[2] See below, Appendix III.

ever, it is possible to base the coefficients on more finely graded estimates. The classification according to economic conditions yields eight classes; the tests for intelligence and for educational attainments yield a mark for each child. Calculated from these data the correlation of economic conditions with attainments is ·35, with intelligence, ·29. These figures are of the same order as those deduced by the rougher method. In an uncompleted investigation carried out under the Medical Research Council, Mrs. Frances Wood has also endeavoured to estimate the correlation between children's intelligence and the economic conditions of their homes. The correlations obtained in various schools ranged between ·26 and ·38; and therefore agree with my own.[1]

It will be observed that the correlation is appreciably higher for school attainments than for intelligence. Thus, over and above the fact that the poor child tends to be a dull child, his poverty, it would seem, is likely to make him

[1] *The Relation between Home Conditions and the Intelligence of School Children* (Medical Research Council, Special Report Series, No. 74): by L. Isserlis from data collected by the late Mrs. Frances Wood. To calculate the two coefficients given in the text (·35 and ·29) I constructed, by a simple method of sampling, a random group that should be as nearly as possible representative of the general population—that is, with a proportionate admixture of brighter and better-class children and with the backward reduced to appropriate numbers. When derived by merely throwing together the children from the control group and the backward group respectively the coefficients are a little larger. The fact that Mrs. Wood's figures are slightly higher than my own may similarly be explained by the fact that her groups included a large proportion of poor children, and the standard deviations seem therefore to have been wider.

It will be observed that the correlation between poverty and backwardness, when based upon individual cases, is only half the size of the correlation obtained when the calculation is based upon a comparison of boroughs. There is, however, no real inconsistency between the two results. Consider the other end of the scholastic scale. If we regarded a University professorship as a mark of scholastic advancement, we should probably find that all those achieving this rank lived in well-to-do districts, and none in districts that were exceedingly poor. The local distribution of academic talent would thus show an almost complete correlation with the economic grade of the neighbourhood. We could not, however, infer that wealth was a necessary condition or an inevitable reward of academic success: nor should we expect so high a correlation between economic circumstances and scholastic success if we turned from districts to individuals.

still more backward in school work than his dull intelligence by itself would lead us to expect. It may be of interest to note that in a similar inquiry upon delinquency I found that the proportions of poor children among my delinquent groups, though large, were not quite so high as those given in the table for backwardness.[1] I conclude that poverty is associated with backwardness in school work somewhat more closely than with dull intelligence, and with both more closely than with delinquency.

2. *Material Conditions of the Home.*—When we think of backwardness at school as one of the effects of poverty, it is essential to ask how precisely can poverty produce it? Plainly the connexion must be indirect rather than direct. In London of to-day, no child is deprived of an efficient elementary education because his parents are too poor to pay for it. Boys and girls going to a free Council school in the slums are taught quite as well as those who pay fees at expensive private schools in wealthier districts, and perhaps even better. If standards of attainment are somewhat lower in those elementary schools that lie in the poorer districts, that is because the schools are forced to reduce their general requirements, not because these schools are willingly content with less.

So far as school progress is concerned, poverty appears to operate in two main directions. It impairs health, and it limits general knowledge. By impoverishing the child's physical vitality, it diminishes his capacity to learn; and by restricting his mental horizon, it deprives him of that preparatory background of worldly lore and culture that most schools take for granted.

The efficiency of the mind varies from day to day with the state of the body; and the body cannot be sustained in full working order if poverty deprives it of proper food, proper clothing, proper housing, and proper sleep. In particular, as we shall see in a moment, continued malnutrition may leave the mind more or less permanently enfeebled. But a closer inquiry seems to show that such consequences are neither so widespread nor so far-reaching as is commonly supposed. Again and again I noted that, although in the

[1] *The Young Delinquent*, p. 64.

poorest homes the parents might be manifestly underfed, the children's health seemed fairly well maintained. A number bore signs suggestive of gross under-nourishment during the pre-school period; but malnutrition due to existing social hardship was observed in only 10 per cent. of the backward cases. And, if my observations can be trusted, it would seem that it is mainly during early infancy that poverty tends to stunt the young child's mental and physical growth.

It has, indeed, long been officially recognized that the child who comes to school hungry and half-starved is in no fit condition to wrestle with intellectual tasks; and consequently in normal times physical debility among school children from sheer want of food is now quite exceptional. In well-organized areas at the date of my survey, the Education (Provision of Meals) Acts (1906 and 1914),[1] together with the activities of the school care committees, had almost entirely abolished gross instances of underfeeding. The child from the needy home seems more often to be suffering from improper food than from insufficient food. He may be dosed, and even over-dosed, with bread, potatoes, and tea; but the diet is ill-chosen rather than too scanty. The choice is largely determined by cheapness; but many parents have still to learn that a child thrives, not by the quantity that it eats, but on what it can digest and assimilate.[2]

[1] The provisions of these Acts, with some modifications, are now incorporated in the Education Act, 1921, sections 82–5. It may be noted that by this Act 'no teacher . . . shall be required as part of his duties to supervise or assist, or to abstain from supervising and assisting in the provision of meals.' Nevertheless, the teacher can at times render much assistance by drawing attention to needy cases; and he may perhaps be reminded that the measure is meant, not as a temporary relief to be administered only in instances of extreme destitution, but as a public provision for any child who is unable, owing to insufficient food, 'to take full advantage of the education provided,' whether his parents are poor or not.

During the period of my investigation the average number of children fed each week by the Council was about 13,000: of the feeding or meals provided about half were dinners, and the remainder chiefly breakfasts, milk, or cod-liver oil.

[2] The effects of early malnutrition, as distinct from current malnutrition, are more difficult to estimate and probably more severe. The reader will

There is another handicap from which the child of poor parents is apt to suffer—more prevalent, but more easily overlooked. Among the weak and weary youngsters of the slums inadequate sleep seems far more frequently to blame for their condition than inadequate meals. Until ten or eleven o'clock at night, in the rougher parts of London, tiny boys and girls of 6 or 7 may be seen playing in the streets, nursing the baby on the doorstep, or waiting for their parents outside the public-house. Even when packed off early to bed, they may not get to sleep until midnight, when older relatives, who share their bed or bedroom, at length rather noisily turn in. During summer the Daylight Saving Bill has operated to cut short the hours of rest: while the sun is up, and the room is bright, children and adults alike forget how late the time may be. This, of course, is no argument against summer-time itself. All that is necessary is that parents should recognize that children must go to bed by the clock, and, if any of them are kept wakeful by the light shining into the bedroom, see that a dark blind is fitted to the window.

Often, when the child is in bed for the requisite number of hours, the conditions under which he tries to sleep may be so unfavourable that wholesome rest is out of the

note that my investigation was completed before the rapid increase of unemployment. It is urgently to be desired that, if possible, some co-operative research should be made upon the effects of unemployment upon the physical and mental development of children in the areas where the conditions have been most severe. The comparison of various groups, studied simultaneously from both the economic and the psychological aspects, should throw a great deal of light upon sociological problems, though no doubt, like all mass-surveys, it will probably raise more questions than it answers.

I may here record some relevant observations made by one of my own research students. In an investigation on the mental capacities of Jewish children, it was noted that malnutrition was far less common among Jewish boys and girls than among non-Jewish, even though both lived in the same poor neighbourhood and the non-Jewish parents were actually earning more: at 10 the Jew is nearly two inches taller and five pounds heavier than the average Gentile. And moreover, it was found that, judged by intelligence tests, Jewish children are on an average nearly half a year ahead of non-Jewish. It is interesting to speculate how far the results are due to racial heredity and more rapid growth, and how far they are attributable to wiser feeding from infancy onwards.

question. There may be an incessant racket in the house or in the street below; there may be several restless relatives in the same room or bed; the bed itself may be desperately uncomfortable, improvised perhaps out of a rickety couch or a couple of hard wooden chairs; the window sashes may be permanently fastened and the chimney blocked up; the bedding just a heap of overcoats, petticoats, and newspapers piled on top of the sleeper, so that his chest is overweighted, and his mouth and nose are smothered, while his toes stick out, cold and uncovered, at the farther end. As a result, he gets up tired and reluctant, bolts his breakfast lest he should be late at school, arrives yawning and exhausted, and can hardly keep his ears open to what his teacher says; so soon as he attempts to read, his eyes feel heavy, and at length, before the afternoon is over, he drops off into a doze. To concentrate for long is utterly impossible; and lessons for which sustained attention is necessary, like memory-work or sums, are never properly attempted.[1]

There are, indeed, many other ways, equally apparent but less easy to remedy, in which bad home conditions may sap the child's vitality. The house may be damp or insanitary, and the rooms overcrowded. There may be no yard or garden for the child to play in. The approaches or the courts around may be shut off from proper ventilation and fresh air. Where the conditions of life are so unhealthy, epidemics of whooping-cough and measles, petty infections like sore eyes or bad colds, will spread from family to family like wild-fire. And, when the children are ill, the parents may have neither the time nor the money, neither the intelligence nor the will, to secure proper treatment from the doctor or the surgeon. Thus, quite apart from sheer underfeeding, poverty is apt to engender a perpetual state of ill-health.

It is, too, the child from the hard-pressed household who accepts employment during out-of-school hours. Paid child-labour, and its effects on work in the classroom, con-

[1] Elsewhere I have reported the remarkable improvement obtained in the arithmetic of a group of backward girls, when they were allowed to sleep for a short period every day during school hours. (*L.C.C. Reports*, No. 1744; cf. *The Subnormal Mind*, p. 123.)

stitute a question that has often been discussed. Many of these overworked youngsters come to school already tired out both in body and mind ; later, as the effects are cumulative, they become pale, haggard, apathetic, and chronically fatigued. Since the passing of the Employment of Children Act in 1903 and of the Education Act in 1921, bye-laws have been framed to meet the problem ; and the paid employment of school children has rapidly diminished. Teachers, however, can still render valuable service by watching the physical state of pupils under their care, and vigilantly checking any contravention of the law.

But paid work is not the only work that drains the energies of the poor. Many, particularly among the girls, have heavy domestic duties to fulfil at home—shopping, scrubbing, washing up, and, when the mother is away at work, minding the home and tending the baby—for, in families such as these, there almost always is a baby. Apart from the sheer physical fatigue that ensues, breakfast and dinner have often to be scamped to make time for household errands ; and, if the housework has to be done in the early morning, the child may reach school half famished and utterly worn out, before the lessons of the day begin. I can call to mind many a case where a backward little drudge, dull, drowsy, and lethargic, was no sooner relieved of these menial tasks at home, than she smartened up in school, and quickly made good the progress she had lost.

3. *Intellectual Conditions of the Home.*—In a well-to-do household, where the family is small and means are adequate, where the father is a workman with an intelligent interest in his work, where the mother is a woman with the inclination and the freedom for intellectual pursuits, the child will begin school life with the foundations of his education already well laid.[1] Before ever he comes to the infants' department,

[1] It is important to recognize that an appreciable proportion (though admittedly a minority) of dull and backward youngsters come from parents in high grade occupations, requiring high grade intelligence, and living in comfortable circumstances. This is an inevitable result of genetic laws—the laws of variability and regression. (For the same two reasons an appreciable proportion of the brighter children come from parents who are in low grade occupations, have only low grade intelligence, and are extremely poor.)

he will be encouraged to teach himself to read, and soon will be expected to pen little letters to his uncles or aunts. As he grows older, he will pick up almost as much general knowledge at home as in the classroom; he will learn more during his leisure hours about the world and its ways than he does from any formal lessons at school. His father and mother will have both time and ability to answer his childish questions, and to join or direct him in his games, his home-lessons, and his visits to places of interest. Instead of being left to play with a crowd of small brothers and sisters, he may be the chief companion of his parents, and the object of their intellectual pride; at meals, and in the evenings, and during his walks abroad, he will share their conversation, and thus imbibe from day to day a miscellaneous store of worldly wisdom. In such a home he will have abundant means to educate himself: he will be given educative toys when he is tiny; and, when he is older, he will be allowed access to his father's bookshelf, and receive pocket money to buy books and magazines of his own. This pre-school information and these out-of-school acquirements will prove invaluable in giving a content and a meaning to the more abstract instruction provided by the school itself.

With the poor child all this is reversed. His mother and father know astonishingly little of any life except their own, and have neither the time nor the leisure, neither the ability nor the disposition, to impart what little they know. The mother's conversation may be chiefly limited to the topics of cleaning, cooking, and scolding. The father, when not at work, may spend most of his time 'round the corner' refreshing a worn-out body, or sitting by the fire with cap on and coat off, sucking his pipe in gloomy silence. The vocabulary that the child absorbs is restricted to a few hundred words, most of them inaccurate, uncouth, or mispronounced, and the rest unfit for reproduction in the schoolroom. In the home itself there is no literature that deserves the title; and the child's whole universe is closed in and circumscribed by walls of brick and a pall of smoke. From one end of the year to the other, he may go no farther than the nearest shops or the neighbouring recrea-

tion ground. The country or the seaside are mere words to him, dimly suggesting some place to which cripples are sent after an accident, visualized perhaps in terms of some photographic 'souvenir from Southend' or some pictorial 'memento from Margate,' all framed in shells, brought back by his parents on a bank-holiday trip a few weeks after their wedding.

The meagreness of the general information possessed by such a child is difficult to credit. To illustrate its amazing paucity, I may cite the results of a small inquiry made among pupils from the lower standards in one of the poorest quarters just outside the City. The children were mainly between 7 and 8, thorough little Cockneys, having spent, with few exceptions, the whole of their short lives within earshot of Bow bells. Of these town-bred boys and girls, nearly 350 in number, 46 per cent., I found, had never to their knowledge seen any other animal besides a horse, a cat, and a dog; 16 per cent. thought a sheep much larger than a cow; 23 per cent. had never set eyes on a field or a patch of grass, even in a Council park; 64 per cent. had never travelled in a train; and 98 per cent. had never seen the sea. With an intellectual background such as this, how many of the statements conveyed to them by teachers or by reading-books must remain mere meaningless formulæ with no mental picture to correspond!

This hopeless ignorance of common matters is, of course, not exclusively confined to children from poor homes. Sometimes, even where the family is comfortably off, the standard of culture is still lamentably low. In the household of many a skilled workman or artisan, nothing but daily work, daily meals, and weekly recreations of the crudest type, make up the chief interests of the members. The only reading-matter left about by the adults may be a picture paper on weekdays, a Sunday paper devoted mainly to murder and divorce, and an occasional evening edition taken for the sporting news. Intellectual culture is thought of as a thing peculiar to the teaching profession, disdained and perhaps actively discountenanced as an unworthy and pedantic affectation. 'Book learning,' said a burly bus conductor to me once, 'isn't for kids that'll have to earn

their bread,' adding, with ambiguous mispronunciation, 'it's only for them as likes to give themselves the hairs of the 'ighbrow.' And his attitude and outlook are typical of many a hardworking parent.

4. *Emotional and Moral Conditions of the Home.*—Nor is it sufficient to consider only the intellectual or cultural status of the home. The moral tone, the emotional atmosphere of the family life, may equally react on the child's school work. If within the home there is a general attitude of slackness, irregularity, and evasion, the child himself is likely to become unpunctual and remiss outside the house as well as within it; he may grow deceptive and dishonest in all his dealings, and quickly turn into a truant or a cheat. The anxieties, the quarrels, the gaieties of his relatives, are liable to upset the balance of his own self-control; and, as every teacher can testify, after each week-end and after each long holiday, many a pupil returns to school worn out, unsettled, or even half demoralized. The key to much inattentiveness in the classroom lies in the events of the child's daily life at home. His mind may be fixed, not on his lessons, but on his own personal problems—brooding over his mother's harsh treatment, worrying over his father's monetary trials, day-dreaming of a time when all will be smooth and rosy.

Sometimes the parents cannot or will not co-operate. Sometimes they are openly hostile. Antagonism between parent and teacher, between the home and the school authority, is nearly always infectious, and becomes a frequent cause of indifference or opposition in the child himself. The effects are so often unsuspected by the teacher that it is worth while illustrating them by a couple of concrete instances from my list.

The mother of one of the backward children in my group had been reproached by the head mistress for not providing her eldest girl with spectacles. The refusal continued; the reproaches were repeated; and the whole affair developed into an open feud—at any rate on the side of the mother. Two years later the girl's younger sister was promoted from the infants' to the same department. In the infants' school she had been keen, docile, and industrious. Very quickly

she came to share her mother's resentment; and her attitude subtly showed itself in class by a growing carelessness and laziness, and a kind of silent and passive defiance. Evidently the child felt, more or less unconsciously, that, however much her teachers reproved her, she would always have her mother on her side. She had been tested by her teacher in the infants' department; and, fourteen months later, I tested her myself. The change in the child's attitude was plainly reflected in the test-results. In little over a year her educational ratio had sunk from 91 per cent. to 83.

Another incident is still more instructive. During the war, while an air-raid was in progress, an ex-soldier came to one of the Council schools at the head of a band of parents, demanding the shelter of the building. As the ringleader of the group, he was taken to task by the headmaster for his aggressive and insolent behaviour. Five years later his youngest son came under the charge of the same headmaster. Hitherto quiet, amenable, and hard-working, the boy seemed suddenly to lose all respect for school and school discipline. When the war-time incident was recalled, the unexpected change was easily accounted for; but it was only by reconciling the parent and the teacher, and by persuading the father to forget his old animosity, at any rate in front of his son, that the lad's deference to authority could be re-awakened and his interest in school work revived.

When the friction arises over the backward child himself, the lack of co-operation is still more disastrous. Sometimes the teacher has to complain that the child is unpunctual, untidy, or irregular in attendance; and the mother, in her endeavour to defend herself and shield the boy, is led to make hasty retorts or false excuses before the boy himself. Sometimes the teacher reports that the child is idle or stupid in the classroom, and asks that his efforts shall be seconded by a little pressure at home; and the parents, feeling that more is being demanded than the boy can be expected to perform, declare that he is no more stupid than they are—a pronouncement that is at times literally true. Not infrequently the parents themselves disagree: the

father chides the boy as indolent and good-for-nothing; the mother protects and spoils him like a baby. The effects upon the child may be readily foreseen.

Usually, however, the adverse influences lurking in the background are subtler, more complex, and far harder to trace. Accordingly, it cannot be too strongly insisted that, in every home inquiry, it is never enough to note the material conditions alone. The moral attitude, the cultural background, the emotional relations between the different relatives, have all to be closely studied and watched.

5. *The Conditions of the Neighbourhood.*—But the child's out-of-school environment does not consist solely of his house and family. It also includes, particularly for the older boy, the streets around, and the playfellows he meets there. The social investigator, therefore, must extend his observations. Often, indeed, the character of the home can be largely guessed from its neighbourhood; and, conversely, the cumulative influences of the neighbourhood can be inferred from the inside of a single house. Yet sometimes there is a difference. The wholesome upbringing the child has enjoyed in an earnest and respectable household may be altogether nullified by the experiences that he encounters beyond the street door. A sudden change in his attitude towards school life may find its explanation here. The outlook of the child himself is bound to be coloured by the ideals of his boon companions. If in their view it is more manly to profess a distaste for books and lessons, and a facetious scorn for the class teacher, then the smartest and most conscientious worker will soon grow ashamed of his superior prowess and zeal.

On the other hand, the effects may occasionally be transposed; and the opportunities afforded by the district may help in some small measure to counterbalance the limitations of the home. When health and knowledge are cramped indoors, they sometimes expand outside. If there is no yard or garden adjoining the house, there may be a park or playing-field at the other end of the road; and always there is the road itself. To the urchin whose travels are confined to a half-mile radius from his doorstep, what he hears and sees from the pavement may prove

the richest source of that fund of worldly shrewdness which he gradually accumulates for himself. After all, for those who learn not from books but from life, what can be more informative than the scenes of a London street—'that mighty place of education, the favourite school of Dickens and Defoe'?[1] Has not Stevenson, in his *Apology for Idlers*, assured us that the 'odds and ends he came by in the open street while playing truant' were worth 'all the lack-lustre periods in the class or lecture hall'?

Yet, even in London, streets and districts differ. Should the lad live near a railway terminus, or close to a busy thoroughfare with its large and inviting shop windows or lively bills and posters on the hoardings, he will often pick up, during his desultory rambles, some vivid and fragmentary notions about the civilized world of to-day. Many a small child has gleaned a knowledge of money values from the tickets in shop windows; has practised reading from the huge advertisements on the hoardings; and has learnt his geography of England from an illuminated map outside a station. But at times, it must be confessed, the features of the city streets are all too stimulating. The East-ender is tempted to shirk school for the fun of prowling round the docks; and the West-ender to spend in the picture palace or the fun fair hours that should be given to healthy recreation out of doors.

Other neighbourhoods are as monotonous as these are provocative. If the child's ramblings are limited to those genteel suburban areas, where nothing is to be seen but row after row of red-brick villas, or block after block of tenement buildings, where 'Respectability' (in the phrase of the American satirist) 'stalks the byways unashamed,' what is there to stir his imagination or to kindle his childish interests? In these dull but decorous districts, the code of the inhabitants is severely against their children 'being seen in the streets.' Hence, even when there is the stimulus of stores and stations and picture-palace placards near at hand, and thrilling episodes to be witnessed from the kerbstone, the prudent parent, not wholly without reason, will forbid her boy to loiter outside the house. The shopping is done,

[1] R. L. Stevenson, *loc. cit.*, p. 73.

not by the child, but by the mother; the child stays at home and plays in the small back-yard. And so he loses, not only fresh air and companionship, but the sharpness of eye, the readiness of response, and all the titbits of miscellaneous information that the street arab, less vigilantly supervised, precociously snaps up for himself.

Summary.—How far are the predictable effects of these various conditions disclosed by our statistical findings? Unfortunately, in each individual case, a good deal has to be decided by personal impression and even by mere guesswork—though it may be the guesswork of an acute and experienced observer. So far as the data can be trusted, the chief figures are as follows: 20 per cent. of my backward cases came, as we have seen, from poverty-stricken families. In 8 per cent. the child's health and vigour were gravely impaired by the material conditions of his life at home; in 16 per cent. his education was seriously hampered by its low intellectual conditions; emotional and moral troubles were noted in 11 per cent.; and in 3 per cent. the conditions of the neighbourhood seemed definitely inimical. On the other hand, in the control group, even where poverty was present, these various concomitants of poverty were far less frequently discerned.

If, however, I were to single out the one feature in the home which showed the closest relation to the child's school progress, it would be, not the economic or industrial status of the family, but the efficiency of the mother. We have already noted how closely this conditions the child's physical development during the first few years of life. But in later years it has an immediate influence, no less profound, on the child's whole intellectual growth. At the same time, by affecting his comfort, cheerfulness, conscientiousness, and bodily fitness from day to day, it acts through subtler channels, indirect as well as direct. Wherever the child's mother is lacking in intelligence, in temperamental stability, or in general force of character, where she is indifferent to the mental welfare of her family, or herself overburdened by domestic worries or by frailties of heredity and health, there the child's whole mental and moral development suffers together.

The characteristics of the backward child's home, family, and neighbourhood I have discussed in some detail, because, though older teachers must be sufficiently familiar with all I have described, the inexperienced have still to learn what a powerful influence is exercised upon their pupils' work by circumstances outside the school walls. In huge cities like London, the teacher often lives miles away from his pupils; and, though the parents may come to the school, the masters seldom visit the homes. It is only when a teacher has moved from one district to another, and taught a wide variety of children, that he begins to appreciate how differences in social conditions may entirely alter the type of mind with which he has to cope.

So far, however, our study of causes has covered only what we have found in the child's external surroundings—his environment at school, on the one hand, and at home, on the other. But school and home can produce backwardness only by affecting the child's individual development. Our next step, therefore, must be to turn from the environment to the child himself. We shall have to study him at first-hand along the lines laid down in an earlier chapter; and in the course of the examination we shall have to inquire whether, besides external factors, inborn or hereditary causes may not also come into play. Only then shall we be able to decide how far the school can counteract the adverse influences outside it, and to what extent the teacher may hope to compensate for shortcomings that are inherited or innate.[1]

[1] Considerable light on the influence of home and parental conditions has been thrown by the changes precipitated by the war, particularly by the evacuation of school children from bombed areas. Generally speaking, it may be said, children from good homes have shown a slight increase in neurotic disturbances (but nothing like the amount predicted); children from poor homes have actually benefited by the change; but everywhere juvenile delinquency (as in the last war) has increased. The more important references will be found in a bibliographical note appended in *Brit. J. Educ. Psych.*, XI, 1941, p. 98, and J. L. Despert, *Child Reactions to the War* (New York: Cornell University, 1942).

FIG. 2.—'MENTAL AND PHYSICAL DEVELOPMENT WEAK.'
Girl aged $10\frac{6}{12}$. Mental age, 8·5; educational age, 7·5; height, 117 cm. (equivalent age, 8·0); weight, 19·5 kg. (equivalent age, 7·5).

CHAPTER VI

PHYSICAL CONDITIONS

(A) Defects of Development

The Relation between Physical and Mental Development.—In describing the examination of the backward child himself, it will be convenient to consider physical conditions first and turn later to mental. Physical conditions I shall discuss under three main heads—first, those that are indicative of the child's natural rate of development; secondly, those that are indicative of general weakness or ill-health; and, thirdly, those that are indicative of more specific disabilities likely to interfere directly with the daily work of the classroom—in particular, defects of the senses, of hand-movement, and of speech.

We have found reason to believe that the dull and the intrinsically backward suffer primarily from retarded development. It is therefore incumbent on us to ask whether this characteristic retardation is limited to the mind alone, or whether it arises as a special aspect of a more general retardation that affects the child's physical development as well. Certainly, throughout the first two or three years of life all forms of growth seem closely correlated. At this early stage the infant's rate of physical development affords a valuable predictive index of his later development mentally. The child who is backward in walking, talking, or even cutting his teeth, is apt to prove backward later on in intellectual progress. How far is it justifiable to make similar deductions among children of school age? If, for example, a boy of 8 or 9 is backward physically as well as mentally, does that mean that he is never likely to develop to the full? Or does it rather signify that some remoter factor—malnutrition, an unhealthy environment, or chronic disease—is hampering both physical and mental develop-

ment, so that, could this factor be removed, he would quickly compensate for previous checks and ultimately catch up with the normal ?

Physical Maturity.—The existence of some connexion between physical and mental development all through the years of growth can hardly be questioned: the crudest observations are sufficient to reveal it. What is doubtful is its amount at different stages. How then can we measure its significance more precisely ? How can we estimate the exact degree to which backwardness in general mentality depends on delay in bodily growth ?

The first step will be to devise some method for assessing physical maturity.[1] Several expedients may be suggested We may begin by reviewing them briefly in turn.

Physical Age : (1) *As Measured by Height*.—The passing observer usually gauges a child's bodily development by noting how tall he is. But height can be measured in quantitative terms ; and, for estimating what may be termed the child's physical age as distinct from his mental age, height seems, on the whole, the best of all rough and ready criteria. In both sexes, and at nearly every age, it furnishes the highest average correlation with other modes of assessing physical development. How far then does it correlate with mental development ?

On collecting measurements from rather more than a thousand London boys, aged 7 to 14—a fair and representative sample of the pupils in the upper departments—I find that the correlation between height and mental age (as given by the Binet-Simon tests) is over ·88. With girls of the same age-range it is higher still (see Table VIII). Much of the correlation must be due to the common influence of chronological age : naturally, the older the boy, the taller will he be in body and the more developed in mind. Never-

[1] The data in this section are taken from my Report on *The Relations between Physical and Mental Development* (1921). Factor analyses of bodily measurements reveal, at every age so far studied, a general factor responsible for about 50 per cent. of the variance, and identifiable with the effects of general bodily growth. Height and weight usually yield by far the largest correlations with this general factor.

theless, the whole correlation can hardly be explained away on this single ground: for the correlation between chronological age and mental age is by no means perfect; with the boys it is about ·86 and with the girls about ·91.

It would appear, therefore, that the child's actual physical development has at least as strong an effect upon his mental level—or at any rate is quite as closely linked with it—as his mere age by the calendar: in other words, the rate of physiological growth must have as much influence on the growth of intelligence as the simple passage of time. If, by the usual statistical method, we eliminate the effect of chronological age, then the connexion stands out by itself. On applying the usual formula for partial correlation, I find that, when the common influence of chronological age is allowed for, the specific correlation between height and mental age is ·48 for the boys and ·51 for the girls. Or we can discount the effect of age more directly by simply selecting boys born in the same year, and re-calculating the correlation between height and mental age for (say) the ten-year-olds alone. Averaging the several coefficients recalculated from the separate age-groups, I get much the same figure. The average correlation between height and mental level for boys of the same age works out at ·44. For girls it is somewhat larger, namely, ·49. In schools recruited from a mixed population, girls aged 11 in Standard VI may be over three inches taller than those of the same age in Standard II or III.[1]

(2) *As Measured by Weight.*—If, for our estimate of bodily growth, we take weight instead of height, the

[1] The result of the first extensive measurements of height in London schools was to demonstrate this connexion. Dr. Kerr's figures for the correlation between stature and school progress among children of the same chronological age are, for boys, ·39 ± ·02, girls, ·52 ± ·02 (*Report of L.C.C. School Medical Officer*, 1907, p. 15).

In my own investigation the correlation for height and chronological age appears to be somewhat higher than that reported by earlier investigators who give figures. If calculated for older children only, particularly about the age of puberty, when increase in height is in many already almost arrested, it tends to be smaller. In these islands the most recent investigation is that of Shepherd Dawson at Glasgow, who found correlations of ·86 for boys and ·88 for girls ('Intelligence and Disease,' *Medical Research Council Special*

coefficients are lower (see Table VIII). Calculated for the separate age-groups they average ·37 for boys and ·35 for girls. There is, too, more variation in the correlation coefficients obtained with weight: for example, among the girls of 13 it is barely ·21. The variations are largely due to the occasional occurrence, especially towards puberty, of fat and heavy children, who are dull and inert, and appear to form pathological exceptions to the general rule. In good neighbourhoods, the correlation of intelligence with weight is nearly always less than its correlation with height; in poor neighbourhoods it may be larger. In the main, it would seem, height forms a better index of growth, and weight of physical condition.

TABLE VIII. CORRELATIONS BETWEEN HEIGHT, WEIGHT, AGE, AND INTELLIGENCE

	Boys.	Girls.
Total Correlations:		
Height and Mental Age . .	·881	·916
Weight and Mental Age . .	·844	·885
Height and Chronological Age .	·903	·915
Weight and Chronological Age .	·872	·904
Mental Age and Chronological Age	·858	·907
Partial Correlations: (Chronological Age Eliminated)		
Height and Mental Age . .	·481	·507
Weight and Mental Age . .	·381	·361

Report Series, No. 162, H.M. Stationery Office, 1931, p. 48). His groups, however, were hospital patients, and therefore not necessarily typical.

Generally speaking, the correlation between intelligence and physical maturity as estimated by height and weight tends to diminish with age. (Just before puberty, except in the case of weight among girls, it may increase a little.) The diminution is only to be expected. Mental level can be directly related to physical growth only while physical growth is actually going on; and it is not necessary that both should always cease together. Among adults, traces of a positive correlation are still discernible. In a mixed group of adults whom I have tested (chiefly for vocational guidance) I find a correlation of ·26 among the men and ·21 among the women (p.e. about $\pm$ ·06). In London, University students appear to be nearly half an inch taller than the average population. It is interesting to note that, among 86 English men of genius whose stature is recorded, 50 are above average height (viz. 5 feet 9 inches) and only 29 below it (Havelock Ellis, *A Study of British Genius*, 1904, p. 206).

No doubt, height as well as weight depends on other factors beside the mere inborn impetus to grow; weight, however, is more particularly affected by nourishment, exercise, and general health—in short, by numerous accidental conditions that are not inherent in the child himself, but result from his environment. If we eliminate the influence of height upon weight, there still remains an appreciable correlation between weight and mental age (·21 among the boys and ·17 among the girls): that is to say, on taking a number of children all of the same age and all of the same height, the more intelligent children prove to be somewhat heavier, solider, and better nourished, while the dull and backward are a little lighter and more frail. How far this is due to the direct effect of a healthy life and diet upon the manifestations of intelligence, as judged by the ordinary tests, how far it is due to the fact that the more intelligent families are both able and willing to give better attention to hygienic conditions, and how far it is an outcome of a fundamental impulse to grow more rapidly in all directions, it would be difficult to say.[1]

[1] Whether measured in terms of weight, or height, or weight divided by height, or by any other means, physical development proves to be markedly influenced by healthy surroundings. But, so far as I am aware, no one has definitely demonstrated to what extent mental development is affected by similar conditions. Such tests as the Binet-Simon scale are put forward as measuring inborn intelligence, that is to say, the level that a child's mental development has reached by virtue of its own original and inherent momentum. But the results of such tests, as I have shown elsewhere, may be greatly influenced by schooling. It would be interesting to inquire whether they are not also influenced, directly as well as indirectly, by the material circumstances of the home. Could we take a dozen infants, destined under existing conditions to grow up into dull slum-urchins, and rear them from the start in an ideal home-environment instead of in an overcrowded, poverty-stricken tenement, would not their mental age in the long run be proportionately higher? Here is a problem calling urgently for research. I hazard the belief that some measure of improvement would be discernible, but that it would not be so great as the social reformer and the ordinary man are tempted to declare. Certainly, foundlings brought up under the most healthy conditions show, both by their average mental age and by their individual differences, that the degree of their intelligence, as estimated by the usual tests, is still to a large extent hereditary or at any rate inborn. More recently Shepherd Dawson, in the investigation carried out under the Medical Research Council and quoted above, has shown that 'acute and

Analysis of the individual variations, however, reveals one suggestive point. If we take a group of 100 boys aged 5 –[1] we find that their mental ages will range from about 3 to 8 years; by 10 – they will range from about 6 to nearly 15, *i.e.* the range will nearly have doubled. If we measure their stature, we shall find that the heights of the five-year-olds range from about 3 feet (91 cm.) to 3 feet 10 inches (116 cm.), or, in terms of equivalent ages, from just under 3½ years to rather over 7½; by 10 the range will be from about 3 feet 9 inches (114 cm.) to 4 feet 9 inches (144 cm.) —roughly the averages of boys of 7½ and 14: as with intelligence, the range has nearly doubled. If we measure their weight, the result is still much the same as before, namely, a range that is equivalent to about 5 years for the five-year-olds and to about 7 or 8 years for the ten-year-olds. Thus, it would seem that, alike in physical characteristics and in mental, individuals differ more and more, the older they grow.

To compare the actual range, however, is, as we have seen,[2] a somewhat inexact procedure. Instead, therefore, we may compare what we have called the average range or average deviation, calculated in the form of a standard deviation and expressed in terms of physical years.[3] When this is done, two general results emerge: first, individual variability for all these characteristics shows a steady tendency to increase more or less proportionately with age, and, secondly, at every age, individual variability appears to be of much the same order both in physical characteristics and in mental. It is difficult to escape the conclusion that both in physical and in mental development individual

chronic general disease, even when it involves long periods of invalidism and absence from school, has little if any harmful effect on intelligence' as measured by standard tests. 'On the whole, it was only in cases where there was disease of the ductless glands or of the brain that there was any appreciable departure from normal intelligence' ('Intelligence and Disease,' *loc. cit. sup.*, pp. 4, 51).

[1] I use this abbreviation to mean 5 to 6, *i.e.* 5 last birthday.

[2] Cf. above, Chapter II, p. 22.

[3] Standard deviations at each age are given for height and weight in Appendix II and for intelligence in my *Report on Mental and Scholastic Tests* (p. 145).

differences are governed by much the same fundamental principles.[1]

[1] In the case of height it would be truer still to say that individual variability increases proportionately with the average height at each age: for detailed figures, see Appendix II. The point is of special interest in view of the steady relation between age and the standard deviation for intelligence, shown by the constancy of the mental ratio, and of the pressing importance of re-calculating, with greater care and precision, the standard deviation of the total population in terms of the mental ratio itself. So far as my existing data go, it would seem that the range of variation in mental characteristics is slightly wider than in physical. For intelligence, for example, the standard deviation lies between 13 and 15 per cent. of age, and for special aptitudes it appears larger still; for height it is about 12 or 13 per cent.

There are several factors which disturb the general relation between variability and age. If differences in intelligence, height, and weight were distributed, like errors of measurement, according to the laws of chance, we might expect them, at any rate in the adult, when the inherited limit is reached by each individual, to follow the normal curve. If, however, an individual's inherited height or intelligence is really determined by numerous Mendelian factors, it can be demonstrated that the mathematical expectation is not precisely a normal curve, but a skew curve, closely resembling it except for a prolongation of one tail and a sharp peaking near the mode—the two features which, as I have elsewhere shown, characterize the distribution of intellectual abilities in children. Actually the distribution of height, as is well known, approximates pretty nearly to the normal curve; and, although the distribution of intelligence and educational abilities approximates to the normal curve nearly enough to be treated as normal for all practical purposes, nevertheless it diverges sufficiently from it for the divergence to be statistically significant when the numbers are large (see *Distribution of Educational Abilities*, p. 34, and *Mental and Scholastic Tests*, p. 162). As for weight, if differences in height are distributed normally, differences in weight cannot be; for weight depends on tri-dimensional growth while height depends on growth in one dimension only; as a further consequence, the ratio of the standard deviation to the mean increases far more rapidly for weight when expressed in the original units (kilograms or pounds). Moreover, pathological factors may still further spoil the symmetry of the curve of distribution. They may, for example, diminish intelligence, but could hardly ever increase it; they may diminish height and weight, but occasionally increase them, especially weight. Further, even if we assume that the distributions are approximately symmetrical when growth is over, they will not be symmetrical during the period of growth. There is, first of all, at the earlier ages what may be called a 'floor effect.' At these ages the existence of a fixed zero restricts downward variability very considerably, for no child can have less than zero height or weight; and even those who grow most rapidly must start from zero. Secondly, at the later ages there is often a 'ceiling effect,' due presumably to an ill-defined physiological upper limit to growth. These two factors prolong the upward tail of the curve with

Numerous attempts have been made to combine measurements of height and weight into a single coefficient which shall give a summary index for the state of a child's physical development. Clearly, a lanky child who is over average height but under average weight, or an obese child who is over average weight but under average height, can neither of them be regarded as well-developed for his age. Often, therefore, it is necessary to consider the two measurements together. Various empirical formulæ have been proposed, chiefly with a view to obtaining a quantitative criterion for distinguishing a well-nourished from an ill-nourished physique. I shall briefly discuss them when I come to consider nutrition. For the purpose of assessing physical development (which is by no means the same thing as the state of nutrition), satisfactory results seem to be given by a method which is far simpler than those commonly suggested—namely, averaging what may be called physical ages as calculated from norms of height and weight respectively. By the aid of a table of averages, measurements of stature and weight, originally obtained in inches or pounds, may be converted into equivalent age-assignments. Physical development can then be roughly expressed in terms of a corresponding age, much as intelligence is measured by a mental age in the Binet-Simon scale. This is by far the most useful mode of comparison. In practice it is convenient to have each age-average chalked upon the measuring rod or weighing scale, against the average heights and weights for each successive year.[1]

younger children and the downward tail with older children. Finally, during periods of rapid growth, variability is necessarily greater ; this introduces additional irregularities in the changes of standard deviation, and in particular, as growth itself draws to a close, the standard deviation tends to diminish.

[1] In considering development as distinct from nutrition, it is perhaps better, as well as simpler, to take merely the age corresponding to the child's actual height : for London children the averages are given in Appendix II, and may be used as norms. At the older ages the figures differ appreciably for boys and girls, so that the indications for one sex will not serve for the other. Some have also argued that a child should be compared with those who belong, not only to his own age and sex, but also to his own social class. Within the elementary schools of one and the same area this seems hardly necessary : but certainly it would be unfair to use averages

So far as height and weight are concerned, then, our general conclusion is this. Among children of the same age, *the brighter seem, on the whole, taller and better developed than the dull.*[1] It must be emphasized, however, that the correlation is far from perfect: it is a correlation that holds only of the mass, not of the individual.

(3) *As Gauged by Physical Proportions.*—Apart from his absolute height, a boy's physical development may also be gauged by the relative proportions of his body. Different parts of the body grow at very different speeds. In physique no less than in mentality, it is absurd to picture an infant as simply a miniature adult. If a baby were to expand uniformly all over till he reached the adult stature, we should at once set him down as a monstrosity: he would look all head and belly, with trunk too long, shoulders too narrow, legs and arms too short, and body far too thick. Hence, in addition to noting actual stature, a practised eye will pick out one child as having an infantile physique and another as having a superannuated face and frame. In theory, if we made detailed measurements of the various parts of the body, as well as of its total height and weight, we could express the development of each constituent member by its ratio to the whole; and so estimate maturity, not by absolute growth, but by the

worked out for London elementary schools as norms of comparison for boys at a public school or for pupils in Ayrshire or the North Riding. In any case, such a series of growth-norms must not be used too mechanically. To some extent each child is a law unto himself. A boy may be two or three inches shorter and three or four pounds lighter than the theoretical average, and yet be quite up to the level which, for his particular race, family, or anthropological type, is really normal at his age.

[1] This conclusion is in keeping with the results of practically all the surveys carried out in the schools of different countries—England, America, Russia, and France. The only important exceptions are the early results of West and Gilbert. J. A. Gilbert, whose researches were at one time frequently quoted, found no correlation between height or weight and mental ability (*Studies Yale Psych. Lab.*, II, 1894, pp. 40 *et seq.*; *Univ. Iowa Studies*, I, 1897, pp. 1–39): G. West actually found negative correlations (*Science*, IV, 1896, p. 156). These two investigators judged intelligence, however, not by mental tests nor even by class or standard, but by teachers' estimates, and therefore apparently introduced the same fallacy as I have mentioned above.

relative dimensions of the several segments—that is, by the degree to which the child approaches adult proportions or exhibits the proportions proper to his age and type.[1]

The differences are most strikingly shown in the changes of the young child's face. We can all of us distinguish a babyish physiognomy from one that is prematurely aged. The snub nose, the tiny jaws, the undeveloped brows, the padded cheeks, the widely separated eyes, the large, well-rounded, and receding cranium, as well as the lack of muscular prominences and of lines and wrinkles on the skin—these and countless other indications are read like a label at the first single glance. Such points, and similar diagnostic symptoms, summed up more easily by a total impression than by any combination of measurements, should be noted incidentally in estimating the physical maturity of each child. They hardly lend themselves to exact statistical analysis ; but, so far as they can be trusted, they yield one of the highest correlations with the child's general development as assessed by a fuller and more detailed study.

(4) *As Measured by Ossification of Bones.*—Besides mere stature and bulk, and besides our impression of the child's proportionate development, there are several other means of assessing physical growth which deserve a passing reference. In the main they are methods for further research ; but at times they may be instructive for practical purposes.

A possible index of maturity is provided, not by the mere length or proportions of the bones, but by their progressive ossification. Every parent knows that the bones of the young child are neither so hard nor so brittle as the bones of an adult. They consist more of soft gristle than of rigid bone ; and consequently when injured they bend rather than break. Now the transformation of gristle or cartilage

[1] Of the factors indicating bodily proportions, that for relative leanness is fairly constant from age to age. The trunk and leg factors, and (especially in pubertal boys and girls) the shoulder and hip factors, show greater fluctuations. The head-and-face factor yields a correlation with maturity even higher than height or weight.

into osseous or true bony tissue proceeds by definite stages. The gradual change is seen most clearly in the wrist. Under X-rays the growing wrist can easily be photographed; and the number of the bones, and the area of hard dense tissue, disclosed by the shadows in the radiograph, yield convenient indications of the extent of ossification. Two (sometimes three) bones appear by the age of 2; six (sometimes seven) by the age of 6. By the age of 13 in girls and 14 in boys all the eight carpals have ossified.[1]

Ossification, as measured by the area of the wrist bones, correlates closely with height: the coefficients are ·87 for boys and ·76 for girls.[2] The radiographs show very strikingly how girls mature earlier than boys: measured by the amount of ossification so disclosed, the girl of 2 is as old anatomically as a boy of 2½, and the girl of 10 as a boy of nearly 12.[3] This accords with the well-established fact that the physical and mental development of girls, particularly in the middle and later standards of the senior departments, is slightly in advance of the boys'.[4]

The most elaborate application of this method is to be found in a research carried out by the Harvard Graduate School of Education, aided by a subsidy from the American Commonwealth Fund.[5] Nearly a thousand children were

[1] See, for a popular and accessible summary, Woodrow, *Brightness and Dullness in Children*, pp. 109 *et seq.* The stages in the transformation were first systematically studied by J. W. Pryor in a series of papers on 'The Chronology and Order of Ossification of the Bones of the Human Carpus' (*Bulletins of the State College of Kentucky*, 1905–8) and the educational implications drawn by T. M. Rotch, 'Roentgen-Ray Methods applied to the Grading of Early Life' (*Am. Phys. Ed. Rev.*, June 1910).

[2] Baldwin, *Physical Growth of Children*, p. 167.

[3] See Pryor, *loc. cit.*

[4] In the physical and mental measurements that I have collected, the sex differences, as I have shown elsewhere, are not so great as is popularly supposed. Among London children even at their maximum (*i.e.* just before puberty) the differences between boys and girls seldom amount to more than the equivalent of half a year. American investigators, however, appear to find a bigger difference between the two sexes both in mental age and in physical development—notably, for example, in the onset of puberty itself.

[5] Daniel A. Prescott, 'The Determination of Anatomical Age in School Children and its Relation to Mental Development,' *Harvard Monographs in Education*, Series I, No. 5, 1923.

radiographed, and their intelligence measured by the Stanford-Binet scale. Norms for 'anatomical age,' estimated in this way, were calculated first of all. Wide individual differences were then discovered. In a group of about 500 seven-year-old children, the range in anatomical age was from 4 years to over 11. 'Significantly enough,' adds one of the investigators, 'the range in *mental* age of the same group of children was almost exactly the same, namely, from 4 to 12 years, enough to bridge the gap from the kindergarten to the junior high school.'[1] In a larger group of 757, there were 55 dull or defective children with mental ratios between 50 and 80. Among these backward pupils as many as 39, *i.e.* 71 per cent., were shown by the radiographs of their bones to be retarded in anatomical development; they were as immature and raw in their bony growth as in the growth of their intelligence. Of the normal, only 49 per cent. were anatomically retarded; of the supernormal, only 29 per cent.[2]

According to its advocates, the measurement of ossification possesses at least one important advantage over the measurement of height or weight. They maintain that, except perhaps for cases of rickets, the rate of ossification of the skeleton is influenced but little by adverse external circumstances, for example, by lack of exercise or by underfeeding. Certainly, it seems less affected than the actual enlargement of the skeleton as a whole (that is, its increase in length or height), and very much less disturbed than the total increase in body-weight. But in this respect the earlier claims seem hardly to be borne out by the results of more recent research.[3]

[1] Mary M. Wentworth, 'Individual Differences in the Intelligence of School Children,' *Harvard Studies in Education*, Vol. VII, p. 21.

[2] *Loc. cit.*, p. 21. Statistically, the figures cited in the text are less convincing than the lay reader might suppose. We must await the results of investigations still in progress before assuming any close correlation. Doubtless it will be positive: but, I imagine, very much smaller than earlier enthusiasts seem to imply. Here, as so often in psychological statistics, results that hold good of groups are constantly disturbed by special factors in individual cases.

[3] At University College, Professor H. A. Harris and his co-workers have shown how such methods will reveal the incidence of previous periods of ill-

(5) *As Measured by Dentition.*—To radiograph each child's carpal bones would be a procedure far too intricate for everyday use in the school. A simple and allied index, however, is supplied by the eruption of the teeth. The development of teeth and the growth of bones are intimately connected. Every mother proudly rejoices when her baby's first incisor makes an early appearance; and any horse-dealer can tell a colt's age by looking in its mouth. It is not so widely known that the physical maturity of the child at school may be gauged on much the same principle. Fifty years ago it was actually proposed that, in the absence of exact knowledge of the date of a child's birth (which, before registration was systematically carried out, was by no means an uncommon difficulty), the number of erupted teeth might be taken as a measure of the child's chronological age.[1] Now that a birth certificate is generally to be had for the asking, at any rate in the more civilized countries, it would seem that we have here a convenient pointer that may be used to estimate, not age in terms of solar time, but anatomical development.

In Table IX I give the average number of second teeth present (or rather erupted,[2] for some may have been extracted) in boys and girls at each successive year. There

health or malnutrition. The effects are visible as 'lines of arrested growth,' or rather of excessive calcification, near the end of the long bones: the familiar ridges on the nails and the enamel of the teeth are attributed to similar causes. These results are seen in some bones far more easily than in others—in the long bones, for example, far more than in the wrist, and affect the pattern of ossification rather than its extent. In certain animals Professor Harris finds a definite relation between the growth of the brain and the ossification or bony development of the hind-limb, and believes the same holds good within the human species. (For a convenient summary, with detailed references and illustrative photographs, see Board of Education, *The Primary School* (1931), pp. 229 *et seq.*)

[1] J. Levy, 'Eruption of Permanent Teeth as a Test of Age,' *Brit. Med. Journ.*, 1885, II, pp. 241 *et seq.* Cf. also a more recent note in the same periodical by S. Spokes, 'Teeth as a Test of Age,' *Ibid.*, 1905, II, pp. 557–8.

[2] With the permanent incisors and canines the process of eruption may take more than a year, and varies considerably in time with different individuals. For the purposes of this inquiry I have taken eruption to mean, not full eruption (which would be difficult to define and may never be attained), but visibility: as soon as the tip of a cusp is seen projecting through the gum, I have counted the tooth as present.

is an interesting sex-difference. During earlier years boys and girls are fairly level: if anything, boys are a little ahead in the poorer districts and girls in the better districts. But at the second dentition the tendency of the girls towards quicker bony growth is clearly manifest. Throughout the primary school period they are at least one tooth in front of the boys, and, at the ages of 11 and 12, nearly two. Towards the prepubertal period, therefore, their dental development is from six to nine months in advance of their brothers'. After puberty the boys overtake them. This is quite in keeping with the relative growth-rates displayed by the two sexes in other directions.

In Table X I give the average age at which the several pairs of first and second teeth appear from infancy onwards.[1] By simply counting up the number of teeth the child possesses, and then referring to the first table on page 151, the examiner can thus reckon up what might be termed the child's dental age. This may be checked by noting which particular teeth have already broken through, and comparing the observations with the expected age as given by this second table.

For different teeth the range and the individual variability differ considerably. Thus half the boys erupt their lower first molars between the ages of 5·8 and 6·8 years; half

[1] As usual, I have obtained my data by examining approximately a hundred normal children of each sex at each age. Below the age of 7 and beyond the age of 14, the smaller numbers make the figures less reliable. 'A Scale for Measuring Dental Age' has since been suggested by P. Cattell in an article with that title, *School and Society*, 1928, XXVII, pp. 52–6.

Of previous attempts to determine the date of eruption for the different types of teeth, the most important are Boas and Wissler, *Report of U.S. Bureau of Education*, I, 1904, p. 38; C. Röse, 'Uber die mittlere Durchbruchzeit der bleibendenden Zähne des Menschen,' *Deutsch. Monatschr. f. Zahnheilkunde*, 1909, XXVII, pp. 553 *et seq.*; W. W. James and A. T. Pitts, 'Notes on the Date of Eruption in 4,850 Children under Twelve,' *Proc. Roy. Soc. Med.* (*Odont. Sect.*), 1912, V, pp. 80 *et seq.*—the source from which the figures given in the common textbooks are usually drawn; Bean, *Ped. Sem.*, XXI, 1914, 'The Eruption of the Teeth as a Physiological Standard for Testing Development.' Figures based on a recent investigation upon children in selected parts of the country have been published in the *Medical Research Council's Special Report*, No. 97, 'The Incidence of Dental Disease in Children,' 1925.

erupt their lower second premolars between the ages of 10·3 and 13·5 years. As we have seen, such differences in range can best be expressed in the form of the standard deviation. The standard deviation is approximately 0·7 years for the first permanent teeth (first molars); it increases fairly steadily for each succeeding tooth up to about 1·5 years for second premolars, and rises to more than 2 years for the third molars ('wisdom teeth'). According to my data, the canines and second molars, though relatively late, seem far less variable in the date of their appearance (standard deviation, about 1 year); but this may be partly due to the fact that comparatively few children of 14 and over were examined. The general increase in variability is itself of special interest. We have already seen that the constancy of the mental ratio depends on the fact that the standard deviation for mental age increases in almost exact proportion with increasing chronological age; and I have pointed out above that variability in other physical manifestations of growth—height and weight, for example—also increases with increasing age. Here, in individual differences in dentition, we have yet another and an unexpected confirmation of the view I have already put forward—namely, that individual variability in mental development is of much the same order as individual variability in physical development.[1]

In Table XI I give the correlations observed between dental, mental, and chronological ages. It will be seen that the figures are not so high as for height and weight.[2]

[1] Figures for variability in dentition (in the form of probable errors) are also given in the *Medical Research Council's Special Report* (*loc. cit.*, p. 32); but they were obtained by a special method of sampling. J. T. Cohen gives distribution curves for American children in *Journ. Amer. Dental Assoc.*, 1928, XV, pp. 237–41, 'Date of Eruption of Permanent Teeth in a Group of Minneapolis Children.'

[2] Here the figures are based upon somewhat smaller groups, namely, 684 boys and 631 girls—roughly a hundred of each sex from age 7 to 14 (rather fewer in the oldest age-groups). For the total correlations for teeth the probable errors are therefore $\pm$ ·012 and $\pm$ ·011 for the boys, and $\pm$ ·014 and $\pm$ ·011 for the girls.

The few figures to be found in the literature of the subject appear at first

Among children of the same chronological age, the correlation between dental age and mental age averages ·26 for boys and ·21 for girls, and between dental age and height, ·39 and ·41. Among eighty-three dull and backward children, of whose dentition I have kept notes, I find that there is an average retardation in dental age equivalent to 1·23 years; among fifty-six mentally defective children I have found an average retardation of 1·72 years.[1] That these differences and these correlations are merely a manifestation of a maturity delayed all round, I cannot pretend. In many of the dull and deficient, for example, past rickets was an obvious factor affecting both height and teeth, and probably mental development as well. Yet, even if these cases are ruled out, an instructive parallel seems still discernible. The question is one that merits further research. Here perhaps the chief value of the facts revealed is to impress on the practical teacher, and on all concerned with the welfare of the backward child, how, even in the most unexpected connexions, the problem of mental development proves always to be one inseparable aspect of organic development as a whole.

sight to be hopelessly contradictory. Thus Woodrow and Lowell, on examining 100 boys and 100 girls of 7½, and Ethel Abernethy, working with 120 girls of 6 to 12, found practically no specific correlations between dentition and mental age—the coefficients were at once insignificant and negative. (H. H. Woodrow and Frances Lowell, 'Some Data on Anatomical Age and its Relation to Intelligence,' *Ped. Sem.*, XXIX, 1922, p. 257; Ethel Abernethy, 'Correlation in Physical and Mental Growth,' *Journ. Educ. Psych.*, 1925, XVI, pp. 539 *et seq.*). On the other hand, Perkins, on examining 555 children in Chicago, found a specific correlation, positive and significant, and as high as ·47 ('Relation of Dentition to Mental Age,' *Ped. Sem.*, XXXIII, 1926, p. 392). The differences, however, are not irreconcilable. Perkins' group included children ranging from imbeciles of I.Q. 21 to bright children of I.Q. 121; the other two investigators studied a relatively homogeneous group of children from a single school only, or from schools of much the same type; further, their probable errors were three or four times as large as Perkins'.

[1] In a 'Note on the Eruption of Permanent Teeth in a Group of Subnormal Children,' J. T. Cohen and J. E. Anderson show that feebleminded children at Minneapolis have, on an average, almost exactly one erupted tooth less than normal children of the same ages (mainly 7 to 15 years): *Journ. Genetic Psychol.*, 1931, XXXIX, p. 281.

TABLE IX. AVERAGE NUMBER OF SECOND TEETH PRESENT AT EACH AGE

Age last Birthday.	Boys.	Girls.
5 –	1·4	1·7
6 –	5·9	6·1
7 –	9·2	9·4
8 –	11·4	12·0
9 –	13·6	14·4
10 –	16·9	18·5
11 –	22·3	24·1
12 –	25·0	26·8
13 –	26·9	27·5
14 –	27·2	27·6
15 –	28·1	28·0
16 –	28·3	28·1

TABLE X. AVERAGE AGE OF ERUPTION OF FIRST AND SECOND TEETH

Number present.	Teeth last added.	Average Age (in Years). Boys.	Girls.
	First Dentition :		
1	First tooth	0·56	0·58
2	Lower central incisors	0·64	0·66
4	Upper central incisors	0·69	0·70
6	Upper lateral incisors	0·74	0·77
8	Lower lateral incisors	0·98	0·93
12	First molars	1·29	1·21
16	Canines	1·55	1·61
20	Second molars	2·14	2·20
	Second Dentition :		
2	Lower first molars	6·3	6·0
4	Upper first molars	6·4	6·2
6	Lower central incisors	6·7	6·4
8	Upper central incisors	7·7	7·4
10	Lower lateral incisors	8·1	7·8
12	Upper lateral incisors	9·2	8·8
14	Upper first premolars	10·0	9·7
16	Lower canines	10·9	10·1
18	Lower first premolars	11·0	10·5
20	Upper second premolars	11·1	10·8
22	Lower second premolars	11·9	11·3
24	Upper canines	12·2	11·4
26	Lower second molars	12·6	11·9
28	Upper second molars	13·1	12·7
32	Third molars (' wisdom teeth ')	20·1	22·2

TABLE XI. CORRELATIONS BETWEEN NUMBER OF ERUPTED TEETH, AGE, AND INTELLIGENCE

	Boys.	Girls.
Teeth and Mental Age	·732	·697
Teeth and Chronological Age	·763	·770
Mental Age and Chronological Age	·824	·841
Teeth and Mental Age (Chronological Age Eliminated)	·282	·143

(6) *As Indicated by Pubescence.*—With older children a suggestive token of physiological maturity is supplied by the degree of pubescence. The relation between pubertal change and mental development has been studied chiefly in America.[1] In this country few investigations have hitherto been made.

I have been able to conduct a limited inquiry among a small number of young Londoners. A preliminary research gave, for the threshold of pubescence, an average age of 14·8 years among boys and 14·2 among girls, with standard deviations of 1·1 years and 1·6 years respectively.[2] I have now taken boys and girls of 13½ to 14, belonging to four main groups—mentally defective, dull, normal, and supernormal. In each group there are 100 of either sex. Among the boys I find that only 19 per cent. of the mentally defective and 23 per cent. of the dull have reached puberty, as compared with 29 per cent. of the normal and 37 per cent. of the supernormal. Among the girls, where the facts can be more accurately dated, the differences are still more striking. Only 28 per cent. of the mentally defective girls, and only 24 per cent. of the dull girls, have reached puberty, as compared with 39 per cent. of the normal and 48 per cent. of the supernormal. It will be noted that, in this small inquiry, the dull girls were even more delayed than the defective: the difference is slight, and may be due either to chance or to the better nourishment and general hygiene that is secured for needy children attending special schools. Exceptional precocity, too, seems somewhat more common among the defective. In the batch of dull girls, anæmia,

[1] The most important studies are those of C. W. Crampton, 'The Influence of Physiological Age on Scholarship,' *Psychol. Clinic*, I, 1907, pp. 115–20, and 'Anatomical or Physiological versus Chronological Age,' *Ped. Sem.*, XV, 1908, pp. 230–7—brief papers which summarize the longer series of articles on 'Physiological Age: a Fundamental Principle,' *Am. Rev. Phys. Educ.*, XIII, 1908, pp. 141, 214, 268, 345, *et seq*. Terman and his colleagues have also made suggestive inquiries upon this point in comparing normal with supernormal children; see *Genetic Studies of Genius*, Vol. I, 1925.

[2] *The Young Delinquent*, pp. 625–6. During recent years the average age of maturation has appreciably advanced. It is now (1959) 13·83 years for boys and 13·05 years for girls.

or anæmic states, were distinctly prevalent; and these, or their underlying causes, may have acted as additional factors, tending to postpone still further the onset of menstruation and at the same time to hamper progress at school.

In accordance with the popular opinion, it is the dull youth and the foolish girl who are generally put down as 'sexually precocious.' In the strict physiological meaning of the phrase, however, this view is hardly justified. The figures just given point to a different explanation. The dull may be precocious in sexual knowledge; they may even be precocious in sexual experiences; but, apart from a few salient exceptions, in the physical manifestations of sex-development they are by no means premature.[1]

The estimate of physiological maturity furnished by pubescence largely agrees with its assessment by the methods already discussed. The correlation between age of puberty and height is ·47 for boys and ·44 for girls; between age of puberty and weight, ·38 for boys and ·50 for girls. At this stage of life, height and weight appear connected far more closely with pubescence than with mere chronological age. Between age of puberty and mental age the correlations average ·27 and ·32 in the two sexes respectively.[2]

[1] On the other hand, extreme cases of precocious puberty appear rarer still among the supernormal. Of twelve cases of menstruation occurring before 11, I find only one among the supernormal (M.R. 131), three among the dull and backward, four among the mentally defective, while the general intelligence of the rest proves to be about average (M.R. 88 to 109). Among the dull and the defective, the more precocious girls often showed symptoms suggestive of a mild pathological disturbance of the endocrine glands. But even here instances of such precocity were distinctly rare.

[2] Probable errors between $\pm$ ·06 and $\pm$ ·04. The groups examined were practically all of the same chronological age, namely, mostly boys and girls on the point of leaving the elementary school or else children who had just left the elementary school and who were referred for psychological examination on account of delinquency, or the need for vocational guidance, or on account of special problems arising in the secondary school. The comparatively small size of the coefficients indicates that there is plenty of room for marked discrepancies. To the teacher, indeed, interested as he should be more in individual cases than in broad and fluctuating correspondences, the discrepancy will be more instructive than the agreement. In cases that seem

Defective Physical Development among the Backward.—Convinced, then, of the significance of physical growth in any study of the backward child, I have kept careful records of the heights and weights of all who have been the subject of my inquiries, and, as far as possible, have confirmed the impressions so derived by detailed notes on other characteristics. The general results may be most conveniently expressed in terms of what may be called the child's developmental or physiological ratio for the various features observed—that is to say, by the ratio of the child's physiological age as estimated by height, weight, teeth, or other characteristics, to his chronological age. The average ratios are given in Table XII.

TABLE XII. DEVELOPMENTAL RATIOS FOR PHYSICAL CONDITIONS

Basis.	Normal.			Backward.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.
Height	98·2	99·1	98·6	95·4	95·2	95·3
Weight . . .	97·4	98·3	97·8	93·4	96·5	94·9
Physical Proportions .	96·0	95·7	95·8	88·7	90·9	89·8
Teeth	98·3	99·5	98·9	97·8	96·4	97·1
Pubescence . . .	98·1	99·0	98·5	97·1	101·5	99·3

semi-pathological, puberty may at times be markedly precocious or markedly delayed without any corresponding precocity or delay in the child's mental growth.

Of the various reviews of the whole series of problems discussed in this section, perhaps the most important are those of B. T. Baldwin, 'The Physical Growth of Children from Birth to Maturity,' *Univ. Iowa Studies*, 1921, I, p. 196, and Ethel M. Abernethy, 'Correlations in Physical and Mental Growth,' *Journ. Educ. Psychol.*, 1925, XVI, pp. 458–66, 539–46. Baldwin concludes that 'physiological age is directly correlated with stages of mental maturation.' Abernethy finds only 'very low partial correlations between mental age and the commonly accepted indices of physiological and anatomical development.' The divergences between the different investigations may perhaps be largely attributed to the different social circumstances, and, it may be, different racial composition, of the groups from which the data have been obtained. Conclusions, therefore, drawn from a study of elementary school children in a city like London do not necessarily hold good of pupils in other areas or from a different social class.

For general intelligence, it will be remembered, these children had a mental ratio of approximately 78. Physically, therefore, they are, as a group, far less retarded than they are mentally. Their physical retardation is most apparent when estimated by what I have termed in the table 'physical proportions.' In my notes for each boy or girl I have always entered a comment on the child's physical appearance—usually stating that he 'has the general appearance of a child of such and such an age.' Such impressions were based mainly on a half-unconscious estimate of the child's physical proportions, but must also have been influenced by his absolute height and build, his facial expression, and his general deportment: in any case, the estimate is a subjective one, and therefore somewhat precarious and perhaps even biased.[1]

Of the more exact measurements, height shows, in the main, the closest similarity to the mental level, although, with the boys, weight comes a little closer. The figures for pubescence are taken from a small group of children only, nearly all over 13: the large ratio for the girls is due to the occurrence of three somewhat exceptional cases of precocity. It will be remarked that the children in the control group, though normal in intelligence, were physically below standard in every respect.

Height and Weight.—The data for height and weight deserve a fuller study. Table XXXI (Appendix II) gives the averages for the backward boys and girls at each successive age; and, for comparison, similar figures are appended for the normal school population and for educable defectives.

During the main school period (7 – to 13 –), the backward, it will be observed, are on an average about 2·4 cm. (nearly 1 inch) shorter than the normal; the defective about 4 cm. (1½ inches) shorter. Thus in height the back-

[1] After I had realized that I should use these observations for correlating estimates of physical development with those of mental development, I made it a rule to jot down my impressions as to the former at the very first encounter with the child, before testing the child mentally or noting or measuring his height and weight: but even so some spurious correlation may have been introduced.

ward fall between the normal and the defective ; and in this direction their physical growth is, on an average, retarded by rather less than half a year, or about 4·7 per cent. of their chronological age.

As regards weight, backward and defective alike are about 1·4 kg. (roughly 3 lb.) below the standard for their age ; this is equivalent to rather more than half a year in retardation, or about 5·5 per cent. of their chronological age ; but the defective, especially during later years, are nearly equal, and sometimes actually superior, to the backward. Thus the backward are not only below the normal weight for their age ; the boys, and the girls at the earlier ages, are below the normal weight even for their own height. Here no doubt we may see the effects of the inadequate nutrition that has left its mark on so many of the backward children ; at the same time, the extra care and feeding that the defective child receives after transference to the special school presumably help him to put on weight during later years. There are, too, apparent differences between the sexes. The defective girls, and, it would seem, the backward girls as well, fall short of the average height rather more markedly than the backward and defective boys. On the other hand, among the older girls, particularly the defective, there are a number who are excessively heavy for their years.

It may thus be a little fallacious to mass the figures together and compare averages for the several groups. We have to scrutinize the separate cases, and inquire whether the deviations from the normal may not be due to a few outstanding individuals. The very shape of the distribution curves for both backward and defective groups is much more irregular than one would expect even in batches of this comparatively small size, and strongly suggests an admixture of cases more or less abnormal. A closer study of the individual children confirms this inference. It reveals, for example, among the younger defectives a number who seem pathologically stunted, and among the older girls several who seem pathologically over-developed. Among the backward, on the other hand, particularly the backward boys, there are many who are definitely undernourished. In an appreciable number both of the backward

and of the defective, signs of past rickets are still discernible; in others rickets may formerly have played a part, although the more obvious stigmata have apparently disappeared; signs of rickets, however, are by no means uncommon in those whose height is up to or over the average. In a few, there are indications that a mild degree of thyroid deficiency might be responsible alike for lack of physical growth and for lack of mental energy.

We need, therefore, some kind of standard whereby we may pick out the subnormal individuals from within any particular group. Unfortunately, there are, for physical retardation, no convenient or recognized criteria analogous to those now generally accepted for mental retardation. A natural suggestion would be to measure backwardness in physical growth by the method used for backwardness in general intelligence, and to try working out a kind of physical or developmental ratio. If we do so, however, it will become evident that we cannot adopt the same numerical borderline. If we called every child physically backward who has a physical ratio of 85 per cent. or less (*i.e.* who is retarded by at least 15 per cent. when his height or weight is expressed in terms of equivalent age), then nearly 12 per cent. of the whole school population would have to be included in this category. But one could scarcely regard a boy as gravely undeveloped merely because at the age of 10 he had the height of a boy of 8½; he would only be about 2¾ inches below the normal. And when the correlation between physical and mental backwardness is so imperfect, a shortcoming of this sort is too slight to have much significance for our purpose.

Among medical officers on the Continent, a favourite criterion is to regard a boy as under-developed if his height is less than 90 per cent. of the average stature for his years, and under-nourished if his weight is less than 90 per cent. of the average weight for his height.[1] This would mark off about 1½ per cent. of the population: and, when we

[1] Since for stature the standard deviation varies with the average height (measured in inches or centimetres) at each age rather than with age itself, there is some justification for calculating the ratios or percentages from the original measurements instead of from height ages, especially where extreme

were considering intelligence, it will be remembered, the lowest 1½ per cent. were regarded as 'mentally defective.' Let us accept this continental practice, therefore, as an attempt to draw a borderline for the 'physically defective' (in a somewhat specialized sense of that phrase); and inquire how many of the mentally backward are not merely 'backward' but actually 'defective' in physical development to this extent.

Among the backward pupils examined for the purposes of this research, 7 per cent. fall into this category; and among the control group, who, it will be recollected, come from the same poor social class, only 2 per cent. As regards weight, 10 per cent. among the backward and 4 per cent. among the control group are defective in weight as compared with their own stature. I shall, however, discuss defects in weight more fully when I come to examine the incidence of malnutrition. But, even if we exclude the extreme or pathological cases, it still remains evident that the backward group as a whole are inherently characterized by slow or subnormal physical growth. In more than one-half of these milder cases, no external or post-natal cause could be traced such as might have influenced physical development in any conceivable degree.[1]

Significance of Physical Retardation.—By whatever means it is assessed, then, a knowledge of the physiological maturity of a given child and of the speed of his physical growth may be a point of special significance for practical work. It is tempting to inquire whether such knowledge, however crudely based, may not help to estimate the child's general rate of development and so to forecast his probable progress in the future. In particular, it is often argued that, when a child is developing slowly in physical characteristics as well as in mental characteristics, there can be nothing peculiarly abnormal about his mental retardation: if his physiological age departs widely from his chronological age,

deviations have to be considered. But here again the most appropriate type of scale is one based on the standard deviation as unit.

[1] There has been a great improvement in the physical condition of London children during recent years: see *Report on the Heights and Weights and Other Measurements of School Pupils in* 1959 (L.C.C. Information Bureau)

then we should not be astonished to find that his mental age may deviate also, and that in a similar direction. Consequently, many writers have urged that, in calculating the child's mental ratio, the proper denominator to take is his physiological age, not the age given by his birth certificate.

Personally I doubt the wisdom of this proposal. That it is not enough to contrast the backward child's mental age with his chronological age alone, I fully agree; but, save for a few exceptional cases, I am disinclined to recommend that the mental ratio should be calculated systematically on this new basis. For one thing, the assessment of physiological age is too laborious and untrustworthy for such a change to be proposed for universal use; and, for another, we know very little about either the causes or the significance of physical retardation.

On this further point I have endeavoured to collect some small amount of evidence. The batch of backward boys and girls that has formed the main subject of the present inquiry is too small, and has been followed up for too short a time, to yield reliable conclusions as to the prognostic value of such measurements. But at the outset of my work for the London County Council, when I was first studying the predictive significance of the new psychological tests, I decided to examine forthwith a large number of very young children of every category—backward, normal, and supernormal—and to re-examine them, so far as possible, at regular intervals throughout the whole period of development. Accordingly, I planned to measure both their physical and their mental characteristics, first in the infants' department, then in the middle of their school career, thirdly when they were due to leave school, and finally, if I could keep in touch with them, towards the end of adolescence—that is, about the ages of 6, 10, 14, and 18 respectively. The investigation has not yet been completed; but I hope to publish detailed results in the course of a few years. A preliminary survey, however, of the more backward cases in this early group yields the following conclusions. Reviewed in the light of their after-history, the figures suggest that those who are retarded physically as well as mentally fall into three or four main groups.

1. First, there is a large number whose physical and mental retardation seems to be the double expression of an innate or inherited lack of vitality—of a weak developmental impulse, which leads the child to develop slowly during the years of growth, and to come early to an arrest, in nearly every direction. These are often children whose parents and other relatives appear to come of a very poor stock alike in physique and in mentality.

2. There is a second group, in which the slow physical and mental development seems to be the result of disease or malnutrition during the first year or two of life, including the prenatal period. Here again the outlook is not hopeful: the physical retardation, so far from diminishing the significance of the mental retardation, actually makes it more serious. The number in this group, though large, is not so great as I had expected. In the absence of detailed family histories, however, it is not easy to distinguish between this group and the former.

3. In a third group the retarded development seems traceable mainly to malnutrition or disease during the school period itself. Here the outlook is far more encouraging. If the underlying factor is removed, the child's mental development may be accelerated; intellectually he may at last catch up to the normal, though as a rule his physical development remains permanently impaired.

4. Finally, there is a smaller and more dubious group where the child's initial rate of development proves to be misleading. At first, in body as in mind, the child may grow slowly; but his slow growth may be prolonged beyond the normal period, or, towards the end of it, become accelerated. These include cases where even the mental ratio apparently improves as time goes on. To predict this possibility beforehand, however, is hardly ever safe. The most significant clue would appear to be the rate of development of the child's own relatives, particularly his parents, grandparents, or elder brothers and sisters.

The last two groups are fewer in number than the first two. Thus, in the main, if a child is physically retarded as well as mentally retarded, the prospect is less promising rather than more. But if the family history is sound, and

if there are no signs of physical malnutrition or the like during the first year or two of childhood, then the prognosis is better. Even among the backward pupils we are here considering, I find a number of instances where the child's mental age was originally two years behind his chronological age, but only one year behind his physiological age, and, as subsequent inquiries have shown, the mental retardation has turned out to be far less serious than might have been anticipated. In such cases, therefore, there is a reasonable chance that, when the child's physical development begins to catch up, his mental development may be quickened too. An extreme example is seen in the cretin. When treated with thyroid extract, his physical and mental growth often put on pace together. Still, as is now well known, the results of such treatment are disappointing except when started in early infancy. Possibly, in cases less obviously pathological, some milder form of endocrine deficiency may be responsible for the similar but slighter retardation affecting both body and mind. In other instances, where the child seems backward all round, in body as well as in mind, the parent often remarks that other members of the family were also a little slow in growing, but eventually made good. The most promising cases of all are those where some obvious external factor is delaying the child's general development—lack of exercise, of sunshine and fresh air, or of adequate and proper food. Better measures of physical hygiene may then be expected to speed up his mental growth as well.

I conclude, then, that in considering the outlook for the backward child the teacher and the doctor should always take into account the recent rate of the child's physiological growth; and I am disposed to suggest that height, or better height and weight taken together, may form the first, the simplest, and the most convenient means of assessing it. In the following chapter I shall discuss in greater detail what particular pathological causes seem to hinder both physical and mental growth. But, apart from such intervening factors, it is my firm belief that a child's general development is to be regarded as forming in the main a unitary phenomenon. It displays a twofold aspect

—physical and mental; and either aspect may be measured separately by one or other of the various methods available. Any of the measurable results may, it is true, be disturbed by external conditions. Yet all are, to a large extent, the co-ordinate manifestations of one and the same initial momentum, the same common impetus to grow. At every age, the more mature tend to be the more intelligent; equally, it would appear, so soon as a child begins to slacken in physical growth, whether permanently or temporarily, his mental development begins to slow down as well.

Strangely enough, this conclusion is in flat contradiction to the popular view. There is a notion, current among parents and teachers, that rapid physical growth is inimical to rapid mental growth. Often it is thought that, just because the child's energy of growth forms a unitary factor, it must therefore be drawn from a single fund, and consequently cannot be spent in two ways at once. If an excess is drafted off to augment the development of the body, that can only be done at the expense of the mind: when a lad begins suddenly to shoot up, or when a girl begins to put on extra weight, then each of them is forced to mark time in mental growth. It is the 'mighty atom,' so it is generally held, that develops the big, precocious brain.

Undoubtedly, from time to time a few instances may be encountered that seem to accord with this theory: they are, however, so far as my experience runs, always instances of a somewhat special nature, and by no means so frequent as is ordinarily supposed. The commonest is that of the boy or girl at puberty whose physical development seems to be giving a last final spurt, but whose mental development has already touched its limit: the disharmony that ensues—an emotional disturbance rather than an intellectual one—may then be still further responsible for a temporary repression of outward mental alertness. Again, the solemn, sedentary, bespectacled child-prodigy, who sticks indoors poring over books or brooding over examinations, is likely to lose both in height and in weight: but, outside the pages of fiction, the precocious weakling, with the massive skull poised on a puny skeleton, could never be accepted

as an authentic specimen of the bright and supernormal youngster. The other cases of non-correlation are, it would seem, chiefly to be found where the increase or decrease in height or weight is definitely abnormal—where the youth is 'outgrowing his strength,' as we say, or the girl putting on extra bulk. All these, however, are exceptions; and many, if not most of them, are attributable to some pathological disturbance of the endocrine glands. The rule appears to be that, *within normal healthy limits, physical growth and mental growth run parallel.*[1]

Nor is it hard to guess what misleads the teacher on this point. 'It is always the hugest louts,' says one master, 'who are the dullest in my form.' His statement is literally correct: but the implication is false. In any given class the biggest are the dullest because they are the oldest; and hence, to have been left in that class at all, they must be definitely backward. They are not the dullest because they are the biggest for their years. On the contrary, among pupils of their own age, there will probably be several who are taller still; but these will mostly be found in the higher standards. If, then, we allow for these illusions and exceptions, my generalization, I am convinced, will be found fundamentally true: inherent backwardness in physical and mental development is in the main a two-sided expression of one and the same underlying factor—a congenital deficiency in what may be called the original developmental impetus of the child.

[1] The multiple correlation between mental development and combined physical measurements amounts to ·54 at 6, but drops to ·31 at 14. The factorial investigation of physical measurements developed out of Galton's correlational studies of the measurements proposed by Bertillon for the identification of adult criminals. Pearson first suggested using uncorrelated 'index characters,' to be obtained by factorizing the correlation-table according to the principles of multiple correlation (*Biometrika*, I, 1901, p. 209); but apparently made no actual calculations. The methods of measurement and factorization used with London children, and the main results obtained, I have briefly summarized in *Brit. J. Med. Psych.*, XVII, 1938, pp. 184 *et seq.* Dr. Lucy Hoesch-Ernst compared measurements from London children with those from continental children, and found much the same factors in both. Differences in body-type appear at the earliest ages, but are mainly the result of differing growth-rates for differing parts. Detailed tables for different ages are given in the *Report* cited above.

CHAPTER VII

PHYSICAL CONDITIONS

(B) Defects of General Health

General Results.—In the past, much stress has been laid, more particularly by medical writers, on bodily weakness and ill-health as impediments to progress at school. Again and again it has been pointed out that the backward child is an unhealthy child, with a long history of lingering ailments, and a physique that wears the impress of defect and disease. But too often it is forgotten how prevalent physical infirmity and illness are throughout those social classes from which the dull and backward are predominantly drawn. Here, therefore, more than anywhere else, before we can make sure of the cause alleged, comparison with a control group is essential.

In the survey carried out at Birmingham, all the children studied, normal and backward alike, were subjected to a special medical examination by Dr. B. R. Lloyd, who was associated with me in the inquiry and was expressly appointed for that purpose. At the outset Dr. Lloyd and I agreed that we should conduct our investigations in absolute ignorance of each other's theories, methods, or results, and that our tables and provisional reports should be drawn up without any preliminary consultation. We thought it possible that, if one examiner knew in advance which children were defective in the judgment of the other, an unconscious bias might arise; there would be a natural tendency for him to scrutinize such a case more narrowly himself, and so perhaps add spurious weight to some suspected correlation between the several kinds of defect with which we were respectively concerned. We resolved, therefore, to work in relative independence until near the end. Hence, when finally we

TABLE XIII. PHYSICAL CONDITIONS: LONDON

Percentage of Normal, Backward, and Mentally Deficient Children suffering from Physical Defects.

	Normal.			Backward.			Mentally Deficient.	Correlation with Backwardness.
	Boys.	Girls.	Average	Boys.	Girls.	Average		
General:								
Malnutrition:								
Marked . . .	4·2	4·6	4·4	8·3	12·6	10·5	8·3	·24
Slight . . .	13·0	11·6	12·3	15·5	17·7	16·6	15·0	[·10]
Social . . .	9·8	10·1	10·0	10·9	15·7	13·3	6·5	[·09]
Constitutional . .	7·3	6·1	6·7	13·0	14·6	13·8	16·8	·22
Total . . .	17·1	16·2	16·6	23·8	30·3	27·1	23·3	·19
Stunted growth . .	3·1	1·0	2·1	6·2	8·1	7·2	9·5	·31
Rickets . . .	13·0	11·1	12·0	21·7	24·2	23·0	28·8	·23
Spinal curvature . .	7·3	8·6	7·9	8·3	15·2	11·8	15·3	[·12]
Other deformities .	4·2	3·0	3·6	2·6	4·6	3·6	7·8	[·00]
Anæmic conditions .	10·9	13·6	12·3	15·0	21·2	18·1	16·5	·13
Tubercular diathesis .	3·1	2·5	2·8	5·2	3·5	4·4	3·8	[·11]
Rheumatism. . .	2·1	3·5	2·8	3·6	5·6	4·6	7·8	[·12]
Skin disease . . .	4·7	3·5	4·1	5·2	2·5	3·8	3·3	[− ·02]
Mouth, nose, and throat:								
Tonsillitis and adenoids .	10·9	8·6	9·7	21·2	19·2	20·2	27·0	·24
Adenoids only . .	5·7	4·6	5·1	8·8	11·1	10·0	13·8	·19
Tonsillitis only . .	15·5	13·1	14·3	16·1	18·7	17·4	22·3	[·07]
Adenoids total . .	16·6	13·1	14·8	30·1	30·3	30·2	34·3	·28
Enlarged cervical glands	14·0	11·6	12·8	14·5	15·7	15·1	17·5	[·05]
Defective teeth . .	11·4	10·1	10·7	10·9	12·6	11·8	18·9	[·03]
Defective palate . .	8·3	6·1	7·2	10·4	7·1	8·7	16·8	[·05]
Defective nasal formation	9·3	10·6	10·0	15·5	11·6	13·6	18·3	[·10]
Recurrent catarrh .	15·0	13·1	14·1	25·9	23·7	24·8	27·5	·19
Lungs:								
Bronchitis . . .	7·3	5·1	6·1	10·9	7·6	9·2	11·8	[·11]
Pulmonary tuberculosis .	1·0	0·5	0·8	1·0	1·0	1·0	1·5	[·06]
Heart:								
Organic heart disease .	0·5	1·5	1·0	1·0	1·5	1·3	3·8	[·05]
Other defects . .	3·6	4·6	4·1	4·2	5·1	4·6	6·0	[·03]
Nervous system:								
Epilepsy . . .	0·5	0·0	0·3	1·6	0·0	0·8	1·8	[·21]
Chorea . . .	0·5	2·5	1·5	2·6	5·1	3·8	5·3	·21
Hyperthyroidism . .	0·0	2·0	1·0	0·0	3·5	1·8	2·8	[·12]
Recurrent headaches .	3·1	4·6	3·8	4·7	7·1	5·9	9·5	[·10]
Vision:								
Marked defects . .	10·9	13·1	12·0	16·1	20·7	18·4	21·8	·14
Slight	14·5	19·7	17·1	21·2	27·3	24·3	28·5	·13
Total	25·4	32·8	29·2	38·3	48·0	42·7	50·3	·20
Squint . . .	3·6	2·5	3·1	6·7	3·5	5·1	8·3	[·13]
Blepharitis, etc. . .	6·2	4·0	5·1	4·7	6·1	5·4	4·8	[·01]
Hearing:								
Marked defects . .	1·0	1·0	1·0	7·8	5·6	6·7	8·8	·44
Slight	4·7	3·5	4·1	10·9	13·6	12·3	19·5	·29
Total	5·7	4·6	5·1	18·7	19·2	18·9	28·3	·37
Otorrhœa . . .	2·6	2·0	2·3	5·2	3·0	4·1	4·3	[·13]
Speech:								
Marked defects . .	2·1	0·5	1·3	8·3	2·5	5·4	10·8	·33
Slight	6·2	2·0	4·1	11·4	6·6	9·0	13·0	·21
Total	8·3	2·5	5·4	19·7	9·1	14·3	23·8	·29
Left-handedness . .	6·7	3·5	5·1	12·4	8·1	10·2	12·3	·19
Zymotic illnesses (more than three)	8·3	6·6	7·4	14·0	14·6	14·3	15·8	·20
Average	7·2	6·7	7·0	10·9	11·4	11·2	14·2	·16

TABLE XIV. PHYSICAL CONDITIONS: BIRMINGHAM

Percentage of Normal, Backward, and Mentally Deficient Children suffering from Physical Defects.

	Normal.	Backward.	Mentally Deficient.	Correlation with Backwardness.
General:				
Malnutrition:				
Social	10·2	11·2	13·0	[·03]
Constitutional . .	8·6	17·9	27·8	·23
Total	18·8	29·1	40·8	·17
Stunted growth . .	4·1	12·2	25·9	·31
Rickets	20·3	32·7	33·3	·18
Spinal curvature . .	14·2	16·8	22·2	[·05]
Tubercular diathesis .	3·6	8·2	3·7	[·23]
Rheumatism . . .	3·0	6·6	3·7	[·18]
Mouth, Nose, and Throat:				
Adenoids . . .	13·2	25·0	25·9	·18
Enlarged tonsils . .	21·3	23·0	18·5	[·06]
Enlarged glands . .	22·8	24·0	25·9	[·02]
Defective teeth . .	13·2	11·7	18·5	[− ·04]
Defective palate . .	10·7	15·3	22·2	[·12]
Defective nasal formation	11·2	17·3	29·6	[·15]
Recurrent catarrh . .	9·1	16·8	7·4	·20
Lungs:				
Suspected tuberculosis .	2·0	6·6	0·0	·28
Other defects . . .	9·1	12·2	11·1	[·10]
Heart:				
Organic	4·6	6·1	7·4	[·07]
Other defects . .	1·0	1·5	3·7	[·08]
Nervous System:				
Epilepsy	0·5	1·5	0·0	[·20]
Chorea	1·5	2·0	0·0	[·06]
Hyperthyroidism . .	3·0	6·1	3·7	[·15]
Recurrent headaches .	2·5	2·6	7·4	[·01]
Other defects . . .	7·6	12·8	11·1	[·16]
Vision:				
Marked defects . .	11·7	17·9	11·1	[·15]
Slight defects . .	19·3	26·5	37·0	[·12]
Total	31·0	44·4	48·1	·18
Squint	11·7	14·3	14·8	[·07]
Hearing:				
Marked defects . .	1·0	5·6	3·7	·40
Slight defects . .	14·7	18·4	18·5	[·09]
Total	15·7	24·0	22·2	·16
Otorrhœa	3·6	2·6	3·7	[− ·06]
Speech Defects . . .	0·5	5·1	14·8	·49
Left-handedness . .	0·5	3·1	7·4	[·36]
Zymotic illnesses (more than three)	9·1	15·4	18·1	[·17]
Average	9·3	13·8	15·6	·15

met to collate our data, it was both striking and encouraging to discover that our ultimate conclusions—our views on the nature and operation of particular physical defects, and our inferences as to the slighter importance of physical defects generally as compared with that of mental defects—were throughout in close accord.

In London I have relied primarily upon the medical examinations carried out by my colleagues under the Council. But, in every case reported in this research, whether the child was normal or backward, I myself have always kept a careful watch for any physical disability; and all through I have supplemented the existing records of the child's past history by special inquiries addressed to the parents. In this way, ailments which, owing to their mildness, recency, intermittence, or some similar reason, escaped notice during the routine inspections, have occasionally been brought to light; and, at the same time, fairly uniform standards—so difficult with vague and qualitative conditions, like poor nutrition or imperfect sight or hearing—have throughout been preserved.

The figures for the two inquiries are given in Tables XIII and XIV. In all three groups, normal, backward, and defective, the absolute percentages recorded at Birmingham are appreciably higher than those obtained at London: the final averages, duly weighted, work out at 9·8 and 7·5 per cent. respectively. The difference, no doubt, is due in part to a difference of area and still more to differences in social class: as stated in the Birmingham report, we there found that all the groups were distinctly 'overweighted with children from the poorest districts.'[1] But in part perhaps the increase may be due to divergences of method and standard: Dr. Lloyd's examinations were probably more thorough and far-reaching. Within either area,

[1] No first-hand inquiry was undertaken into the social circumstances of the children we examined at Birmingham. We could only rely on information incidentally communicated by the teachers. But even so we found that 8 per cent. of the control group came from homes so poor or so ill-managed that they might justly be called neglected, and almost as many from homes known to be poverty-stricken. I should add that in re-calculating Dr. Lloyd's data I have made one or two slight changes in the figures, where further information or an obvious slip seemed to necessitate the emendation.

however, it may, I think, be safely assumed that method and standard were throughout approximately the same for the two batches there compared—the backward group and the control group. Hence the *relative* differences, as will be seen, are in each city very much the same. This will be found more obvious when the two percentages are reduced to a single index figure, expressing the difference between the backward and the normal in comparable terms: as before, I have used for this purpose the 'tetrachoric' coefficient of correlation.

The Significance of Physical Defects Generally.—Throughout the two tables, as we pass from the normal to the backward, and from the backward to the mentally deficient, the incidence of physical defect and disease, no matter what its particular form, tends regularly to increase. At London the average number suffering from any one defect is, among the normal, barely 7 per cent.; among the backward it rises to nearly 11 per cent.; among the defective it is over 14 per cent. At Birmingham the corresponding proportions are, in round figures, 9, 14, and 16 per cent. respectively.[1]

[1] Although my own figures for normal and defective children are lower than those obtained by Dr. Lloyd, nevertheless they are distinctly higher than those usually found in the annual reports of medical inspections. For this there are several reasons. First of all, the normal cases in my control group were not selected as average samples of the general population, but as coming from the same schools and the same social neighbourhood as the backward. Secondly, far more time was spent over the examination of all the cases summarized in this research. Often they were examined and re-examined on several different occasions and even by several different persons. Thus a defect which was latent, intermittent, or likely to be overlooked under the conditions of an ordinary school inspection—a mild and fluctuating deafness, for example, or a tendency to chorea or catarrh—might be missed at one interview, but noted at another. Thirdly, it must be remembered that at the ordinary medical inspection the object is primarily to discover defects definite enough or marked enough to call for immediate treatment: my own aim, on the other hand, was to detect any condition, however slight, which might lower the child's efficiency in his work at school.

All this goes to show how difficult it is to preserve a uniformity of standard where different examiners are concerned. Actually I believe it would be fair to say that Dr. Lloyd's figures and my own do not differ more from those printed in the medical officers' tables than those do from one another. Moreover, I have noticed that, where a school doctor has made

The increase is steady, but not startling. The figures for the mentally deficient serve to remind us how the backward fall midway between the normal and the children from the special schools, and how the latter are usually but extreme examples of the retarded group considered as a whole: for the rest, they hardly concern us here.

The chief points that we have to examine are whether there is a demonstrable excess of ill-health among the backward as contrasted with the normal, and what may be the relation between physical defects, on the one hand, and educational disabilities on the other. The general answer is clear. The difference between the percentages for the backward groups and the control groups respectively, though small, is too large to be attributable to chance. If we seek to sum up the relationships by means of a single figure, the mean correlation works out as + ·16 at London and + ·15 at Birmingham. The correlation is positive, but exceedingly low. Indeed, in either table, out of thirty or forty coefficients only three or four rise above ·3.

To summarize the results in a more concrete form, it might be said that, on an average, the child who is technically backward suffers from four physical defects, while the child who is educationally normal suffers from about two and a half or three (2·6 if we average the totals from both Birmingham and London). Contrasted with the bright and lively youngster from a good and comfortable home, the backward, no doubt, seem at first glance to be sadly handicapped by a number of petty bodily ailments. Yet,

an intensive study of some particular condition, his figures generally rise more nearly to my own.

For future investigations there is an obvious corollary: what is now really needed is not a tabulation of defects as simply present or absent, but an endeavour to classify the findings according to their severity or degree. Evidently to ask what proportion of the backward children are stunted is a far vaguer question than to ask what is the amount and form of the correlation between height and educational attainments; and, for purposes of research, the discrepancies that spring from varying standards would to some extent be circumvented if conditions such as malnutrition, left-handedness, defective speech, sight, and hearing, and even perhaps the ill effects that arise from adenoids, anæmia, infections, and the like, could be graded, if not always into definable classes, at any rate in order of relative intensity or presumable influence on efficiency and health.

compared with a typical child from their own social sphere —a pupil making average progress in the same elementary school—they show no special or conspicuous differences in their physical condition: the backward lad is afflicted with but one or two more defects; and the addition, as a rule, is no grave deformity or desperate disease, but merely some minor weakness—an obstructed nose, a swollen gland, or a flabby, ill-nourished physique—perhaps a further consequence of the other troubles.[1]

This conclusion may, I think, be fairly drawn from the data collected in London; and, as I have already implied, the same view emerged even more clearly from the Birmingham investigation.[2] The salient feature, therefore, of the two investigations is the unexpectedly small difference in bodily health that they disclose between the normal groups and the retarded. The inference is plain. The presence of physical defects can act as a primary cause of scholastic backwardness in but a slender proportion of the cases. *In the main, bodily weakness and bodily ill-health prove to be contributory factors, not fundamental causes.* They may, perhaps, drag a child down, even though he be naturally bright, from the plane he would otherwise have reached. They may even retard his ultimate development by the equivalent of about six to twelve months' progress. But, unless his inborn mental capacity is subnormal to begin with, and unless his rate of mental growth is inherently slow, they cannot of themselves, except in the rarest instances, hamper his education so much that, by the time he is 13, he will be three or four years behindhand, and fit only for Standard IV instead of Standard VII.

Accordingly, so far as a theoretical inquiry into the causes

[1] It will be noted that, according to my method of tabulating the data, several abnormalities may be recorded each under a separate heading, when all are really parts of one and the same general condition: for example, a child who, in addition to, and perhaps as a consequence of, enlarged tonsils and adenoids, and possibly some early zymotic disease, has developed a defective nasal formation, a septic state of nose and pharynx, swollen glands in the neck, tissues visibly ill-nourished, and a stunting of the whole physique, would be entered as suffering from seven separate defects.

[2] See *loc. cit.*, p. 38, for the conclusion reached by Dr. Lloyd, and *ibid.*, p. 19, for my own.

of backwardness is concerned, I am compelled to argue strongly against the habit of attaching sole or predominant importance to merely physical conditions. But, so soon as practical measures are to be considered, the emphasis is altered. Not for one moment would I under-rate either the need or the value of medical and surgical treatment. For the backward child, indeed, such treatment is peculiarly pressing. Special efforts are required, not so much because he labours under a larger number of defects, nor even because their relief may do something to disencumber his progress in the classroom, but chiefly because, in virtue of his own native dullness, and in virtue, it may be, of the dullness, poverty, and ignorance of his parents, he stands in greater need of competent external aid than those who are better off and more intelligent than he.

The Significance of Particular Defects.—What, then, are the defects that are principally effective?

The figures in the tables allow us in some measure to infer not merely the frequency of the several conditions, but also, in a rough provisional way, the extent to which they interfere with educational progress. The surveys both in London and in Birmingham indicate that many of the defective conditions revealed at medical inspections have no discoverable correlation with backwardness whatever, whereas others are unquestionably associated with it, though in differing degrees.

In the London inquiry the conditions showing a demonstrable correlation are the following. I arrange them in the order of their apparent influence, as estimated by the coefficients[1]: (i) marked defects of hearing; (ii) marked defects of speech; (iii) slight defects of hearing; (iv) enlarged tonsils and adenoids; (v) stunted growth; (vi)

[1] The probable errors of the coefficients, as calculated by the formula usually employed, are so high that the differences between the size of the coefficients would have little significance if judged by that criterion only. I find, however—as, indeed, I have already indicated—that, in the case of the larger coefficients, the relative order of magnitude indicated by the London data agrees with that indicated by the Birmingham data far more closely than might have been anticipated. Hence, where the two inquiries support each other, some reliance may be placed on the order found. (Cf. Appendix III.)

rickets; (vii) marked malnutrition; (viii) recurrent catarrh; (ix) organic nervous disease, such as chorea and probably epilepsy; (x) slight defects of speech; (xi) constitutional malnutrition; (xii) a series of four or more zymotic illnesses; (xiii) adenoids only; (xiv) left-handedness; (xv) defects of vision.

The significance of the following is not so clearly proved: (xvi) squint; (xvii) spinal curvature; (xviii) hyperthyroidism; (xix) rheumatism; (xx) tubercular diathesis; (xxi) bronchitis; (xxii) recurrent headaches; (xxiii) anæmia; (xxiv) slight defects of nutrition; to these should perhaps be added (xxv) malnutrition due to social rather than constitutional causes. But here, it will be remembered, we are comparing normal and backward children from the same social environment. By such a method we should hardly expect to discover the full importance of social handicaps. That we have already studied by comparing the backward group with the general population of the county.

The following appear to have little or no demonstrable relation to backwardness at all: enlarged tonsils (without adenoids), enlarged cervical glands, tuberculosis of the lungs, organic and other defects of the heart, defective palate, defective teeth, external defects of the eyes, diseases of the skin, and miscellaneous deformities other than those included in the above.

In Birmingham the only conditions which showed a plainly demonstrable relation to backwardness were defects of speech, marked defects of hearing, stunted growth, suspected tuberculosis, constitutional malnutrition, recurrent catarrh, adenoids, rickets, and defects of vision; in the case of the following, the figures, though fairly high, were not high enough to prove an unquestionable relationship without the examination of larger numbers: left-handedness, nervous defects (epilepsy, chorea, hyperthyroidism), defective nasal formation, and rheumatism. Considering the small size and the brief character of the inquiry, the conclusions agree sufficiently well with those reached in London.

The Specific Effect of Particular Defects.—To the tabulated figures, taken by themselves, too great an importance must

not be attached. They form merely a succinct and suggestive way of describing the first results of the survey. Percentages and coefficients derived from such data as the present may hint at, but by themselves can never prove, that this condition or that is a cause of backwardness. The best method for establishing a causal influence is either to try to trace it at work in individual cases, or, better still, to observe whether the alleged effect ceases when the suspected cause is removed. If, when his speech is corrected, or his deafness cured, or his health improved by medical or surgical treatment, the intelligent child gradually loses his backwardness, then, other factors remaining as they were, the condition so dealt with may be fairly considered to have been the effective cause. But once again *post hoc ergo propter hoc* is a precarious form of inference, particularly when the individual cases are so few. Hence both lines of evidence are really required, the one corroborating the other.

Accordingly, in tracing the history or watching the progress of each backward individual, an attempt was always made to study the mode in which the presumptive causes had apparently operated, to gauge how far they had produced or aggravated the backwardness he showed, and then to observe the eventual outcome of the remedial measures. My main impressions I shall summarize in this and the next three chapters; and the statistical analysis will be used chiefly to check or verify the conclusions so formed. Since my aim is practical as well as theoretical, I may perhaps be permitted to add a few simple notes, such as may enable the teacher to recognize or at least to understand the various conditions that will be mentioned, and a few tentative suggestions in regard to appropriate treatment.

In the foregoing tables the defects themselves have been classified according to the scheme commonly adopted in medical textbooks and reports—that is, according to the main physiological systems, respiratory, circulatory, nervous, sensory, muscular, and the like. I shall, however, make no effort to adhere rigorously to this order in my comments. To codify the defects under systematic headings is a matter of convenience merely, and to the lay reader might prove as

misleading in discussing physical conditions as it is in discussing mental. As we shall find at the close of our review, more often than not, what is affected is the whole efficiency of the child. The few well-defined defects that stand out as relatively specific—those of sight, hearing, movement, and speech, for example—we may for the moment postpone. In the present chapter I shall deal primarily with the broader conditions affecting general bodily health and fitness; and here, too, I shall in the main confine myself to those that are most frequent and most easily observed.

Such conditions fall primarily within the province of the medical officer rather than of the teacher in the school. Nevertheless, it is desirable that every teacher should know something about their nature. Mind is dependent upon body: all conscious activities have a physical basis. Growth and development itself—mental as well as bodily—form, as we have seen, at bottom a physiological phenomenon, and are therefore almost bound to be disturbed by disturbances of health.

1. *Defective Nutrition.*—Of all the physical characteristics noted in the backward groups, the most distinctive was what may be vaguely termed a state of general malnutrition. Both at London and at Birmingham nearly 30 per cent. seemed, to a greater or lesser extent, visibly ill-nourished. At first sight, we might be tempted to infer that a vast amount of backwardness could be removed simply by a more generous attention to diet and to all those conditions of normal hygiene that make for a well-nourished, well-developed body. A closer scrutiny of the individual cases, however, reveals that the problem is far more intricate than that: a state of imperfect nutrition may be due to many other factors besides sheer lack of food and fresh air. Nor is it easy to define precisely what is meant by an ill-nourished child.

The school doctor is advised by the Board of Education's circular[1] to assess nutrition as distinct from muscular development or physique, and to classify and record on a schedule all children examined as belonging to one or other of four groups: (1) good, (2) normal, (3) subnormal,

[1] Circular 582, 1908.

(4) bad. This fourfold classification is now almost universal; and the figures used in numbering the four categories in order are commonly employed as marks or grades. The circular goes on to urge that reliance should mainly be placed on 'an individual clinical examination': 'height and weight alone are not reliable data unless frequently used.' It may be frankly conceded that, in judging the needs of the individual, nothing short of a systematic clinical examination is to be trusted; but for keeping the standards of different examiners more or less uniform and comparable from one group to another, some definite guide or criterion is wanted, showing what is understood by normal and subnormal nutrition in a typical case.

To formulate such a criterion, however, proves to be a somewhat baffling task. Various suggestions have been put forward. For example, the examiner is recommended to look especially at the spaces between the ribs, and grade each case accordingly: if in direct light the spaces are almost invisible, the child is normally nourished; if they show only below the nipples, he is subnormally nourished; if they show above the nipples as well, he is badly nourished. Or again, the doctor is told to pinch up a fold of the skin by the side of the navel, and measure its thickness with wooden callipers. But clearly such isolated, local tests can have little value as criteria taken by themselves; much less can they furnish a reliable quantitative standard. For general use the simplest and the oldest method is probably the best —the principle I have already adverted to in the preceding chapter. It consists in noting the ratio of weight to height —the figure for height being either left in the original linear units, or, better, first converted to terms of equivalent weight. From the tables given in the appendix[1] the normal

[1] See Table XXXI, Appendix II. As the tables only give measurements at definite intervals or steps, some method of interpolation is needed. A nomograph or chart enabling the calculated result to be read from a scaled diagram saves the trouble of fresh computations for each individual. For most practical purposes, however, the plan already suggested will be found sufficient, namely, to chalk corresponding weights upon the scale used for measuring heights.

In justification of my proposal I may say that, for a few small samples of varying age and sex, where independent estimates of nutrition were fairly

weight for any particular height can easily be derived ; and the ratio may then be computed by taking the actual weight of the child examined and expressing it as a percentage of the average weight of normal children having his actual

reliable, I have calculated the correlation between what may be called the clinical estimates and the estimates based on various indices. That for the weight-height ratio, computed as above, is decidedly the highest (average coefficient, $\cdot 69 \pm \cdot 02$) ; that for simple weight is, on the whole, higher than any other (average coefficient $\cdot 54 \pm \cdot 03$) ; but both coefficients vary somewhat with age and sex. These results are in close accord with those obtained for infants in the investigation carried out under the Medical Research Council (*Poverty, Nutrition, and Growth*, 1926, pp. 62 and 65). Such figures indicate that the index proposed is sufficiently reliable to provide a general standard, but is not likely to be very trustworthy by itself in individual cases.

It may be helpful to other investigators if I briefly summarize and criticize the main alternative suggestions. For constructing an ' index of nutrition ' a wide variety of formulæ have been put forward ; and different medical officers prefer different equations. The two leading principles on which such indices seem tacitly to have been based are these : first, that nutrition primarily depends upon the proportion of flesh and fat to skeleton, and, secondly, that bulk, as estimated by weight, may be used to assess the former, and stature to assess the latter.

Accordingly, the most straightforward and therefore the commonest calculation is the ' gram-centimetre index,' which is as old as Quetelet. Here the figures for weight and height are taken as they stand, namely, in kilograms and centimetres, and the ratio then directly calculated as the percentage of weight to height : *i.e.*

$$\text{Index of Nutrition} = \frac{100 \times W}{H}.$$

Unfortunately, however, the ratio so obtained fluctuates enormously with age—varying, with London children, from about 17 at age 5 to over 27 at 15.

To get rid of this variation with age, other expressions of increasing ingenuity and complexity have at various times been proposed. The most plausible consists in adding a third principle to the other two : weight or bulk, it is argued, really depends upon growth in three dimensions, while height depends upon growth in only one. We ought, therefore, to take either the cube of the height (Rohrer, ' Eine neue Formel zur Bestimmung der Körperfülle,' *Korr. Blatt. d. Ges. f. Anthrop.*, XXXIX, 1908, p. 5) or the cube root of the weight (Livi, ' L'index pondérale ou le rapport entre la taille et le poids,' *Arch. Ital. de Biol.*, XXXII, 1899, p. 229) : *i.e.*

$$\text{Index} = \frac{100 \times W}{H^3} \text{ or } \frac{100 \times \sqrt[3]{W}}{H}.$$

The former was widely used in Germany during and after the war for picking out children whose state of malnutrition called for special charitable

height. As an arbitrary borderline for malnutrition, I have adopted a retardation in weight equivalent to one year's growth, calculating the degree of retardation, not from the weight which would be normal for the child's

assistance, and has since been frequently adopted by school medical officers in this country.

Such a formula would be impeccable if a child's body could be safely treated as a rectangular block of fixed proportions and of uniform substance. But organic growth and structure are far more irregular than that. And, where the relations of the parts are so intricate, naïve, *a priori* principles, like those just cited, can claim little or no validity. During school age children grow more in height than they do in breadth or thickness; and consequently, as I have shown in the appendix, weight varies not with the cube of the height, but only with the $2\frac{1}{4}$ power or thereabouts. On this basis, therefore, if we are still to keep to simple terms, the indices I myself should advocate would be

$$\frac{100 \times W}{1600 \times H^{2\frac{1}{4}}} \text{ for girls, and } \frac{100 \times W}{1716 \times H^{2 \cdot 22}} \text{ for boys.}$$

Incidentally, it may be observed that Quetelet (*Sur l'homme et l'anthropometrie*, 1870) proposed taking the $2\frac{1}{2}$ power of the height. It will be noted that the exponent ($2\frac{1}{4}$) deduced empirically from my data is nearer the square than the cube; and several investigators, without offering any exact mathematical justification, have actually proposed the square. Kaup, for example, has suggested dividing the index W/H by Height again ('Ein Körperproportionsgesetz zur Beurteilung der Längen-, Gewichts-, und Index-Abweichungen einer Populations-Altersgruppe,' *Münch. Med. Wochenschr.*, LXVIII, 1921, p. 976): the same suggestion is also made by Davenport ('The Best Index of Build,' *Amer. Journ. Phys. Anthrop.*, III, 1920, p. 467).

With my own measurements I find that, if the square of the height is taken as the denominator, the percentage rises from about 16 at the age of 5 to 18 at the age of 15; if the cube of the height is taken, it sinks from 16 to 12; if the cube root of the weight for the numerator, the percentage sinks from 2·5 to 2·3. None of these suggestions, therefore, makes a satisfactory allowance for the changing relations between weight and height. Moreover, in actual practice, time would forbid working out such equations for each individual case; and, if we are to refer to a table or graph constructed once for all, it is better to use the actual averages for each age than to calculate the theoretical averages from some abstract algebraic formula, however precise.

Several reasons have been given for preferring, not the total height or stature, but the sitting height—*i.e.* height of trunk, neck, and head, that of the legs being eliminated. This is the basis of von Pirquet's so-called 'Pelidisi factor.' In this country von Pirquet's methods were popularized by Dr. Auden, School Medical Officer for Birmingham, after a visit to von Pirquet's clinic at Vienna. 'By this formula,' it is claimed, 'we can judge whether the actual weight corresponds to the weight expected of an individual of given sitting height'; 'it enables one to know objectively whether a child

age, but from whatever weight would be normal for the child's actual height. Roughly speaking, by this standard any child whose weight falls 10 per cent. (or more) below what would be anticipated from his height would be regarded as ill-nourished.

has the amount of muscular and fatty tissue corresponding to his height and skeleton' (' Sitzhöhe u. Körpergewicht,' *Zeitschr. f. Kinderh.*, XIV, 1916, p. 211: *id.*, *System der Ernährung*, 1917–20). The formula, as ultimately amended, is

$$\frac{\sqrt[3]{10 \times \text{Weight (in grammes)}}}{\text{Sitting Height (in centimetres)}}.$$

In a research carried out under the Birmingham Education Authority, my sister, Dr. Marion Burt, has shown that the distribution of the ratio corresponds closely with the normal curve. It appears, too, to be fairly constant for different age-groups. Children whose ratio falls below 95 may be regarded as abnormally thin; and those whose ratio is over 105 as abnormally adipose (*Value of Vocational Tests as Aids to Choice of Employment*, Birmingham Stationery Department, 1932, pp. 57 *et seq.*). The drawback of the formula is that sitting height is far more difficult to measure accurately than standing height.

Other writers have suggested modifying the simple W/H index by introducing some further factor dependent upon age (*e.g.* multiplying by $\frac{\text{Age} + 1}{\text{Age} + 2}$) or by introducing additional measurements (*e.g.* of the chest circumference, of the upper arm, or of the abdominal layer of fat). During the last thirty years or so a formidable literature on the subject has gradually grown up, each writer testing some earlier formula and finding it fail, and then proposing something more and more ambitious. An instructive review of these criticisms and attempts will be found in Kerr's *Fundamentals of School Health* (1926), pp. 116 *et seq.*, and in the Medical Research Council's *Report on Poverty, Nutrition, and Growth* (1926, pp. 51–7).

My own conclusions are as follows. The ideal method would be to deduce a regression-equation from the partial correlations between nutrition and all the measurable characteristics significantly correlated with it; but in routine examinations the measurement of characteristics other than height and weight is difficult, inaccurate, and best left unattempted. The object of the mathematical manipulation has chiefly been the search for an index that would mark the normal child as 100 and the abnormal as deviating above or (more usually) below. But there is no great virtue in a percentage; it is at once simpler and safer to keep to the actual averages obtained for each age and sex. Whatever system of measurement be selected and whatever borderline be found, the result in individual cases must be far less trustworthy than a direct inspection of the child's condition by a well-trained clinical eye: such measurements are therefore helpful only as applied to groups and as general guides for equating the standards or the borderlines adopted by different observers.

This, however, marks only an average borderline for the group as a whole. With individuals a mere comparison of height and weight would be often useless and sometimes misleading. The experienced eye will always prefer to assess each particular child mainly by his general appearance; and the final judgment will be based on a numerous group of varying signs. Thinness and pallor—the signs chiefly noted by the layman—are by no means the sole or the most significant symptoms: thin, anæmic-looking boys and girls are quite common among the brightest of the scholarship winners, and, unless other symptoms are present, the subsequent histories of such children seldom show undue weakness or deterioration of health.

The state of the several tissues—skin, fat, and muscle—should be closely observed in turn. A pinched or puffy face, sagging facial muscles, with a bagginess about the eyelids, and perhaps a wrinkled forehead suggesting nervous strain; dull eyes, lack-lustre hair, scraggy legs, and flabby upper arms; a narrow chest with ill-covered ribs; a loss of muscular firmness everywhere, with a general absence of balance and poise; a thinness of the fat-layer in the subcutaneous tissues all over the body and especially over the abdomen; at times an excessive adiposity, making the child pulpy and heavy instead of light or under weight; a blanched, unhealthy colour, and in particular a bleaching of the mucous membranes—the conjunctivæ and the gums; dark purplish rings beneath the eyes; cold, bluish, mottled hands, with clammy moistened palms; goose-skin on uncovered parts; a harsh, inelastic surface, or sometimes, in fatty persons, an oily, thick, pigmented surface covered with coarse, superfluous hair—these are the more important symptoms on which the observant teacher or physician may base a final judgment. In brief, it might be said, there are three points to which attention should be directed: the colour of the skin (including the mucous membranes), the tone of the muscles (including those of the face), and the deposit of subcutaneous fat (an excess being regarded as indicative of poor condition quite as much as an insufficiency).

By these criteria and with this general standard, I find that 10 per cent. among the dull and backward children

were gravely ill-nourished—as compared with 4 per cent. among the normal, who, it will be remembered, were drawn largely from poor homes. Another 16 per cent. of the backward showed a minor, but definitely discernible, state of imperfect nutrition.

Guided partly by the child's visible state, and partly by what was known of his history and home-environment, I have endeavoured to separate the ill-nourished individuals into two main groups—cases of social malnutrition and cases of physiological malnutrition respectively: that is to say, first those where the child's condition seemed to be due chiefly to external causes, particularly poor or unsuitable feeding, and secondly those where it seemed due predominantly to constitutional or pathological causes, such as general physical weakness, past or present disease, or some inherent defect of metabolism. The second group is easily overlooked or forgotten. Of those falling within it, a few, especially among the girls, may be quite up to the average weight for their height, and to an unpractised eye may look well-covered; but a narrower inspection reveals that the covering consists chiefly of more or less flabby fat, and that there is a marked deficiency of muscular and vascular tone. And the group as a whole offers by far the more elusive problems not only for diagnosis but also for treatment.[1]

[1] Within this second group may be included one of the most distinctive forms of defective metabolism found among school children—a condition marked by a group of symptoms pointing to a relative shortage of sugar. The condition, familiar enough to the doctor, seems almost unknown to the teacher or parent, and therefore deserves a word of explanation. Such children are usually thin, wiry, overactive youngsters, whose fidgetiness and inattention attract notice in the classroom and whose nervous peculiarities distress their mothers at home. They start at sudden noises; show excessive fears; are often subject to train-sickness, bed-wetting, bilious attacks; and occasionally come first under official notice for repeated pilfering in order to purchase sweets. Their overactive systems seem to consume their body sugars more rapidly than they can assimilate fresh supplies; and, when the sugar has been consumed, they begin to burn up their own fat: this stage can at times be recognized by the heavy sickly odour that characterizes the child's breath, particularly before meals. The diagnosis is clinched by examining the urine for acetone—the by-product that tends to taint the breath. In the severer cases, there are frequent febrile attacks and spells of 'cyclic vomiting.' The fried foods that figure largely in the meals of certain

The tables show the cases of malnutrition sorted, so far as possible, into these two broad types. A subdivision of this kind is bound to be rough and speculative. But, so far as the results can be trusted, it would appear that, among the dull and backward, a lack of proper tissue nourishment is, if anything, more frequently due to constitutional conditions than to social, though the latter are frequent enough.[1] In the control groups, the opposite was the case. In all the groups, both at London and in Birmingham, it was evident that a genuine state of malnutrition was by no means exclusively caused by, and by no means a conclusive sign of, want of sufficient food at home. Even in the non-constitutional cases, poverty was seldom the sole effective factor: other causes, more easily preventable, nearly always co-operated—rapid eating of perfectly good meals, food plentiful but ill-chosen and ill-prepared, a diet deficient in vitamins, or overloaded with carbohydrates, an excess of strong tea, a weak digestion, or a poor assimilation of food, extreme fatigue at home or at school, late hours, closed windows, in short, all the innumerable conditions that do not so much starve the child as leave him delicate and thin. Some of the worst cases were found in respectable families of good social class, particularly in boys and girls who had been kept indoors and so suffered from insufficient light, air, and exercise.

2. *Rickets.*—Where malnutrition dates from very early years, its effects are by no means limited to the condition of muscle, fat, and skin. It may disturb bony growth as well. Indeed, it was chiefly among the ill-nourished dullards that the clearest instances of bad skeletal development were seen.

families, and the cod-liver oil on which misguided mothers so often insist, tend to aggravate the trouble. Excitement and overstrain are further precipitating causes. Indeed, the typical case is that of the youngster who is brought to the doctor with a feverish bout and much vomiting the day after a party at which he has been romping about and consuming numerous cream buns. The condition can often be ameliorated by administering glucose in the form of barley-sugar or the like, with perhaps bicarbonate of soda to neutralize the acid, and by temporarily curtailing the diet, and in particular by cutting down the intake of fat.

[1] This agrees with the observations of Dr. Lloyd upon the cases studied in Birmingham, *loc. cit.*, p. 43.

As the tables show, spinal curvature, minor deformities affecting the bones of the nose and palate, and above all rickets, appeared to be particularly common among the backward and the dull. The correlations between backwardness and stunted physique generally I have already discussed. An appreciable correlation with backwardness, not quite so high, is also revealed, both at London and at Birmingham, by the figures for rickets.

Rickets—'die englische Krankheit'—is not so much a disease of the bones as a disturbance of metabolism, a special form of dietetic malnutrition affecting the bony growth in infancy. It is the most frequent source of osseous deformities; but it brings with it many other deleterious effects. Nearly a quarter of the backward cases in London showed definite skeletal signs of past rickets—bossed foreheads, pigeon breasts, curved spines, beaded ribs, thickened wrist-bones, and, less commonly, bow-legs and knock-knees. Among these, several of the most backward of all had been nominated by their teachers as cases of mental deficiency—the teachers supposing that the rachitic deformities about the child's skull and body formed 'stigmata of degeneracy.'

In Birmingham the figures were higher still. But in both batches of backward children—at Birmingham and London alike—early rickets, stunted growth, malformed palate and nose, adenoidal enlargements, and constantly recurring catarrh, provided one of the commonest syndromes. Contrary to the sex-difference prevailing among the normal, rachitic signs were noted among the backward girls somewhat more frequently than among the backward boys. Children from the darker courts and alleys, and from the high, overcrowded tenement buildings, seemed to suffer markedly; and apparently those born in the last third of the year—the darkest season—yield nearly as large a proportion as those born in all the rest of the year put together.

Towards the older ages the anatomical evidence of rickets tends to become less obvious; hence the percentages, high as they are, must greatly under-estimate the prevalence of this condition. Its frequency among the backward might at first be taken to imply that malnutrition in early infancy,

and the respiratory and catarrhal ailments to which rachitic children are especially liable, may play a most important part in delaying mental growth. Yet, in Birmingham, both malnutrition and rickets were almost as evident among the slightly retarded children within the normal group as among those singled out as dull or backward in the technical sense. Consequently, we seem compelled to conclude that, apart from other adverse factors or sequelæ, the mental effects of rickets in itself may be relatively slight.

3. *Spinal Curvature.*—Often it is possible to guess the backward children in a class simply from their posture as they stand up or march by. The lack of energy which marks the dull child's activities, whether of mind or body, seems to characterize his very attitude, even when he is doing nothing active at all. He sits and stands asymmetrically, all limp and loose and flaccid. When he moves, he heaves himself along with a weary shuffle or slouch. When he stops for a moment, he props himself up with one leg pushed out like a weak buttress and the other supporting his main weight. His feet are flattened and splayed. His knees are slack, so that a little nudge behind them easily throws him off his balance. His chin drops. His shoulder tips droop. His arms drag down. His shoulder-blades project backwards like lumpy little wings. Seen from the side, his head and neck, instead of being well poised above the ankles, poke forward and protrude till the ear comes in front of instead of behind the vertical or central axis of his body. As a test, let the child hold a long pole at his side, and let another child adjust it until it is perpendicular: the postural defects are thus thrown into relief. The unexpanded chest goes in; the relaxed stomach is thrust out; the curves of the back are exaggerated into an S—the upper part about the shoulders being rounded and convex, and the lower part hollowed in or flattened. Seen from behind, the spine may also be twisted to one side or to the other, in most cases to the right: so that the tips of the two shoulder-blades rise to a different level, and one hip sticks out while the other fails to show. Once their significance is realized, these various signs can be rapidly detected by a self-trained

eye; and the teacher should be on the watch for their appearance.

Bad posture, with well-marked spinal curvature, was observed in 12 per cent. of the backward cases in London. Of these, roughly nine out of ten were examples of scoliosis (lateral curvature), and nearly all the rest examples of kyphosis (outward curvature). Among the backward children in Birmingham, Dr. Lloyd's figures were higher still; but they were almost as high among the normal. In both London and Birmingham, spinal curvature—particularly backward or forward (kyphosis or lordosis) as distinct from lateral—was nearly twice as frequent among the girls as among the boys. In the main, no doubt, the higher figure among the girls is to be explained by their rarer opportunities for exercise, their greater instability, and their faster rate of bodily growth towards puberty. I must add that, in my experience, these postural defects seem nearly as common among scholarship winners and among girls in secondary schools as they are among the dull and backward at the same adolescent stage. Judged by the coefficients, the correlation between backwardness and spinal curvature as such, though positive, was not large enough to be really significant. Nevertheless, such curvature was often the most conspicuous characteristic in those ill-developed youngsters who, as I have already pointed out, make up so great a proportion of the dull and backward groups.

Curvature itself is a symptom rather than a cause; and the causes may differ in different cases. Weariness, laziness, and what is popularly called weakness of will, lack of movement and exercise, deficient neuro-muscular tone, proneness to nervous and muscular fatigue, excessive lolling over desks, defective nutrition, defective hearing, defective sight, and in the severer cases early rickets—all of them conditions frequently found among retarded children—these seem to be the commoner sources of such postural defects. Among the poorer girls, too, a daily habit of carrying a heavy baby or a loaded shopping basket on one arm appears occasionally to set up a one-sided attitude; and I have known a similar posture produced in schoolboys or students who go about with a bundle of books wedged under the arm-pit. In my

own groups no instances were found of grave organic causes. With the doubtful exception of a few older or rachitic children, nearly all the cases were functional rather than fixed; and the twist could be temporarily straightened by simply telling the child to bring his feet together, hold himself upright, and make himself as tall as he could.

The importance of postural reflexes, and of the action of the muscles in maintaining bodily attitudes as distinct from executing bodily movements, has been brilliantly brought out by the researches of Sir Charles Sherrington.[1] The implications of his work, both for mental hygiene and for mental and manual activity, have scarcely yet been realized by the teacher in the classroom. Upon the teacher must mainly depend the daily efforts necessary to prevent the child from habitually assuming wrong and lopsided postures. Few of the cases need formal exercises. Most would benefit by better feeding, longer rest, and freer movement in school and in the open air. In particular, sedentary work should be sufficiently reduced to avoid the undue fatigue that sitting imposes on these children. Excellent results are generally obtained if from time to time the child is allowed to take all strain off his weak, atonic back muscles by lying flat on his back without a pillow for half an hour each afternoon, or—better still, if it can be arranged—for short but repeated spells throughout the day. In the junior classes, and more especially in the infants' schools, accommodation should always be provided for lying down in this way; and similar facilities should be available for the backward. But the best principle of all is to arouse the child's own zeal and wish for improvement, as he alone can habituate himself to a better balance of the body.

4. *Defects of Nasal and Palatal Formation.*—A deformed nose and palate, often accompanied by signs of rickets and spinal curvature, and, in particular, by defective development of the chest, seemed recurrent features in that set or cycle of conditions which I have already mentioned as extremely prevalent among the backward and the dull. Indeed, in many of the children from this group, the whole

[1] See especially *The Integrative Action of the Nervous System* (1906), pp. 337 *et seq.*

framework of the respiratory apparatus looked frail and undeveloped. To judge by the figures for the more obvious defects, namely, those of nasal and palatal formation, this general condition appeared somewhat commoner among the boys. How far it is congenital, and how far it is due to malnutrition, climatic exposure, or the ailments of early childhood, would be difficult to determine. In many cases it had certainly been aggravated by, in others perhaps it had induced, recurrent respiratory catarrh. But again, taken by itself, as the coefficients show, an ill-formed nose or palate has but slight significance : it would evidently be rash, with the old-fashioned theorist, to count these minor deformities as 'stigmata' of mental dullness or deficiency.

5. *Recurrent Catarrh.*—The frequent occurrence of catarrh, in one or more of its numerous manifestations, among the backward and the dull is a point of some significance. Naturally we expect a child showing signs of poor nutrition and resultant debility to present a low immunity to these mild but troublesome infections ; but catarrhal conditions seem exceptionally prevalent in those whose faces are marked by developmental defects—by the round receding forehead, the protruding muzzle, the short and upturned nose, the thickened lips, which combine to give to the slum child's profile a negroid or almost simian outline. Once again, these are the very defects that are singled out as 'stigmata of degeneracy' and supposed to indicate a throw-back to some primitive stock ; and often the primitive, impulsive conduct of these youngsters seems to bear out this notion. 'Apes that are hardly anthropoid' was the comment of one headmaster, who liked to sum up his cases in a phrase.

In point of fact, however, there is no need to invoke the doctrine of ancestral reversion. The true cause is probably much simpler. Both the appearance and the behaviour of these children may be explained as acquired rather than as innate characteristics. Emotional instability and a nervous temperament may be direct results of the rheumatic or quasi-choreic condition which these catarrhal infections set up. And a defective development of the facial bones and respiratory passages is, as we have seen, a frequent con-

sequence of early malnutrition, and the like. Such structural defects must undoubtedly enhance the liability to catarrh, and the chronic catarrh, with the consequent blockage, will interfere still further with normal growth.

The whole condition could be obviated or remedied by more careful measures of hygiene, in which the school should play its part. With better-arranged periods for exercise and rest, better diet (including perhaps a cup of fresh milk during the morning session), and above all rational open-air treatment, children with these catarrhal tendencies can be much improved. Too often, however, the open-air treatment of the ordinary school means simply inflicting fresh chills by unwise attempts at ventilation, lowering the temperature, and creating draughts. In the classroom a common cold easily arises and quickly spreads; yet its presence is almost always disregarded. Many of the backward children in my groups were declared to be scarcely ever without the symptoms of a cold; and a condition so chronic and uncomfortable must not only increase inattention and liability to fatigue, but may also lead—as was demonstrated in many instances—to headaches, sore throats, sore eyes, pains in the limbs, inflamed mucosæ generally, perhaps even to affections of heart or lungs, and so suggest an unhealthy diathesis like those so often denominated rheumatic or tubercular. Cases of this kind are particularly frequent in the damp, low-lying areas.[1]

6. *Hypertrophied Tonsils and Adenoids.*—Of the dull and backward cases in London, as many as 37 per cent. were observed at one time or another to be suffering from some form of tonsillar trouble—an unexpectedly high proportion. Most were cases of chronic enlargement and congestion. Adenoid growths,[2] sometimes slight, sometimes severe, and

[1] See the comments below on the geographical distribution of the more definite types of rheumatic affection, such as chorea and heart disease: p. 197.

[2] The roof and back of the nasopharynx is the seat of lymphoid tissue, sometimes gathered into a mass and called the pharyngeal tonsil. This tissue may undergo an enlargement analogous to the chronic hypertrophy of the visible tonsils in ordinary tonsillitis—with which, indeed, it is commonly associated. The enlargement usually takes the form of protuberant growths or 'vegetations.' Bacteria lodge in the recesses; and the whole not only becomes infected and inflamed, but seriously blocks the

often occurring in conjunction with tonsillar enlargement, appeared almost as common. A number of these cases also showed at the time of the examination an infected condition of the nose or throat; this was noted with especial frequency among girls of the catarrhal type just mentioned. By itself (if the coefficients of correlation can be trusted) tonsillitis has little effect on the child's mental activity in school. But when attended by rheumatic symptoms or associated with adenoids as well, its consequences are clearly discernible. The largest numbers were found in the junior classes of the upper departments, that is, between the ages of 7 and 10.

The importance of adenoids, and of nasal and pharyngeal obstruction generally, has been stressed again and again. Few physical conditions have been so constantly accused of engendering mental dullness; and every teacher can now recognize an adenoidal face. Since the nose is blocked,[1] the child breathes through his mouth; and mouth-breathing is, therefore, the most conspicuous symptom: it should be remembered, however, that the mouth-breathing may be continued as a habit long after the obstruction has been removed. The open lips and drooping jaw impart a peculiarly fatuous look. The child snores at night and inhales noisily during the day; his voice becomes thick, expressionless, and nasal. Since the air-pressure within the nasal cavities is regularly diminished, the nose and facial bones remain undeveloped; the bridge of the nose is flattened and the eyes are wide apart and rather full; the wings of the nose collapse; the nostrils look pinched; the palate becomes highly arched and narrowed; and the upper teeth in consequence are crowded and project.[2]

respiratory passages. To these enlargements the name 'adenoids' (*i.e.* 'gland-like') is now generally given. In spite of its prevalence it is only fifty years since Meyer first drew attention to the condition.

[1] The blocking of the nose may be roughly tested by closing first one nostril, and then the other, with the forefinger pressed against the side of it; the child is then told to keep his mouth shut and to try to breathe in.

[2] In many cases perhaps cause and effect are reversed. The undeveloped nose and palate, due, as we have seen, to poor skeletal growth, foster the adenoid enlargements. For this view, and for a cautious and critical study of the whole question, see Yearsley, 'Occurrence of Adenoids in London County Council Schools,' *Journal of Children's Diseases* (1910, February and March).

FIG. 3—'ADENOIDAL FACIES.'
Boy aged $10\frac{1}{12}$. Mental age, 7·5; educational age, 6·0.

The diminution of air-pressure within the chest renders it sunken and pigeon-breasted; the bony sternum sticks out like a keel, and the softer cartilages fall in.

As regards mentality, the child often seems more undeveloped than he really is. In the worst cases the power of application is appreciably weakened; the child looks dense, vacuous, and sleepy, and at times becomes timid and fretful. Sleep is constantly disturbed; the child wakes up unrefreshed, and appears even too tired to play. He is peculiarly slow in the uptake; and, since he fails to attend, his memory is weak: while the impression that he so often gives of general stupidity may be still further heightened by the fact that, for part of the time, he is a little deaf.

In the classroom the milder cases show great variability. On certain days the child seems fairly sharp and attentive; on others, when his nose and throat are inflamed with catarrh, or swollen and congested from the dampness of the air, he becomes vacant, day-dreamy, and extremely absent-minded. The lessons that depend most on mental application, and are especially hindered by fatigue, are the lessons that suffer most conspicuously; at Birmingham it was in the group of children picked out as specifically backward in arithmetic that the highest proportion of enlarged tonsils and adenoids was discovered.

As the tables show, the correlation between adenoids and general backwardness—·28 in London and ·18 in Birmingham—is one of the highest in the list of purely medical defects. Even so, the coefficients are not large. Thus the figures suggest, and many of the case-histories corroborate the view, that the effect of adenoids upon intelligence has been somewhat exaggerated: the teacher expects too much from their extirpation. He himself, however, can be of direct assistance; for quite as much depends on proper measures of hygiene after the surgeon has done his task. Breathing exercises may be of great value, not only after the operation, but also in those milder cases where an operation may be deemed unnecessary.[1]

[1] I should like to urge that, in considering the desirability of such operations, their probable effects on the nervous and emotional condition of the child should always be borne in mind.

But the best examples of mental improvement that I have noted were in children sent back to playground classes and kept mainly in the open air.

It so happens that, among the London children whose tonsils and adenoids had been excised, many, for one reason or another, had been tested both before and after the operation. At the second test several showed a definite advance in scholastic subjects, particularly in mental arithmetic, but only a trifling advance in tests of intelligence—rarely more than would naturally be accounted for by spontaneous growth during the interval that had elapsed. This, however, is only to be expected. Tests of intelligence are designed to measure innate ability, not actual or net efficiency; and, at the very first examination, the examiner, by virtue of his technique, endeavours to see that his examinees hear properly, attend carefully, and do their best, however much they may be handicapped at the time by fatigue or poor health. Improvement in health and general fitness, therefore, should not affect a test of pure intelligence.[1]

7. *Defective Teeth*.—Another common condition often blamed for backwardness is the presence of bad teeth. Under this heading I have entered all cases where there was a record of dental caries or allied conditions grave enough to affect general health and comfort: children with less than four decayed teeth were usually classed as satisfactory. Contrary to expectation, such defects—even when untreated—seemed to have had little or no influence upon the

[1] Terman and others agree in finding no significant improvement in the mental ratios of children after such operations: a review of the various results is given by Gladys M. Low, *Psychological Clinic*, IV, 1923. But the comment in the text applies equally to these American studies: if the mental ratio is an index of innate rather than acquired ability, it should, in theory at any rate, remain unaffected by variations in the child's health. Hence it is rather by the results of scholastic tests that the mental effects of treatment should be judged. A systematic research is still much to be desired on the degree to which educational efficiency, as distinct from general intelligence, is benefited by the operation. My own re-testing was carried out for routine purposes, not for any inquiry on this subject. Consequently, the comparisons are merely incidental; and I can offer no statistics showing what proportion of the cases were definitely improved.

children's mental efficiency or school work. The rare and doubtful exceptions were noted chiefly among those who were backward in arithmetic. After all, it is hard to concentrate on sums when a tooth is aching or health has been sapped by gumboils and free pus.

The worst cases were found in weak and undersized youngsters of a rachitic type, whose bony growth seemed altogether poor; and my impression was that the bad teeth were not so much a cause as a result of continuous low vitality and feeble health. For the rest, my experience fully bears out that of my colleague Dr. Kerr, who writes 'except in very bad cases there appears to be no direct relationship between dental conditions and the state of general nutrition.' [1] Between dental conditions and educational progress, the relation, as the coefficients in Birmingham and London show, is virtually zero.[2]

Of the physical defects I have so far described, the majority affect the pupil's work chiefly by their injurious influence on his general health and vitality. I now turn to those that affect more specifically his nervous system. All the nervous disorders that were definitely diagnosed or recorded—chorea, epilepsy, hyperthyroidism, and the like—show fairly high correlations with backwardness. But

[1] *Loc. cit.*, p. 140.

[2] Many claims have been made for a connexion between bad teeth and bad scholarship; yet little evidence can be found to show that the one causes the other. On the physical side, one or two fairly thorough investigations carried out in Germany indicate that, during childhood at any rate, defective teeth are less prejudicial to health than is commonly supposed. (See Henneberg, 'Ein Beitrag zur Zahnfrage,' *Zeitschr. für Schulgesundheit*, 1911, pp. 894 *et seq.*; also Ernst, *ibid.*, 1912, pp. 241–4). On the psychological side, practically the only research is the study undertaken by Dr. J. E. W. Wallin with the aid of a committee of the National Dental Association in America. Twenty-seven backward children with bad teeth were subjected to a year's dental treatment and hygiene: they were tested at the beginning and at the end of the year; they showed an improvement of about 50 per cent. in all tests. Unfortunately, however, as Dr. Wallin himself regrets, he was unable to organize a control group. Hence we do not know how much of the improvement was due to the special hygienic measures, how much was due to an extra year of normal mental growth, or, finally, how much was due to the inevitable improvement that is found when novel tests are repeated a second time. (See 'Experimental Oral Euthenics,' *Dental Cosmos*, 1912, April and May.)

the cases are so few that the coefficients themselves are far less significant than might be imagined from their size.

Among children nervous disorders tend to undermine steady mental work, not so much by damaging the intellect as by unbalancing the temperament. Teachers are apt to picture such disorders as literally diseases of the brain, and to expect that 'brain-work' must in consequence be inevitably impaired. If we are to use anatomical words in a metaphorical sense, then it is the child's 'nerves' and not his 'brain' that are more likely to succumb. But the actual effects are better described in psychological than in physiological language: what are primarily disturbed are the child's emotions: the disturbance of intellectual capacity—of attention, memory, and reasoning—is usually secondary and indirect.

8. *Epilepsy*.—Here we may glance first at what are generally regarded as organic troubles; and leave the functional till later. Of all organic nervous disorders that affect the school child, epilepsy is the most serious; but it is also one of the rarest.[1] Epilepsy, however, denotes a

[1] As given by the schedules, the number of epileptic children of school age in London during the period of my survey amounted, in round figures, to between 150 and 200, the numbers varying according to the year. This is far smaller than any other defective group—blind, deaf, physically defective, or mentally defective; and is equivalent to less than ·025 per cent. of the total scheduled population. Of this number 5 per cent. were under instruction at ordinary schools, 10 per cent. at special schools, 50 per cent. at homes or institutions, and 35 per cent. not under instruction at all. The diagnosis of epilepsy is fraught with difficulties; and my colleague Dr. Kerr has estimated that the total number of school children in London needing prophylaxis against chronic epilepsy is actually nearer one thousand than a couple of hundred (*Fundamentals of School Health*, p. 403).

On making a small but intensive investigation in sample districts I found that between 1 and 2 per thousand of the population are apparently epileptic —say, on an average, about 0·15 per cent. A large proportion of the cases are unknown to the school authorities. Of those for whom detailed information was obtainable, nearly one-third are intellectually deficient; rather less than one-third are temperamentally deficient or unstable; and rather more than one-third technically normal, but frequently dull or backward.

There is evidently an urgent need for a systematic inquiry into the whole subject. The educational problem is by no means disposed of by enjoining that the severer cases (which in practice generally means children who have had a fit in school) shall be recommended for a residential institution; and

group of diseases rather than a single disease; and in some forms certainly the seizures may be due to local disease of the brain. It has long been known that many epileptics show an intellectual deterioration often amounting to mental deficiency or dementia, though several writers [1] have recently maintained that even here the primary defect is in most cases emotional rather than intellectual. On applying intelligence tests to a group of epileptic children of various ages, Shepherd Dawson found that 40 per cent. were dull and backward, and another 22 per cent. mentally defective: a few were actually above the normal. On re-testing the group after an interval of about one to four years he found that the majority had still further deteriorated.[2] This agrees with my own experience: of the epileptic children I have tested I find that only about one-third are approximately normal in intelligence; the remainder, during school age at any rate, are more often dull than positively defective. The statement so often quoted [3] to the effect that 'children who develop epileptic fits before the age of 7 are destined to become idiots incapable of education' is not borne out by the results of actual testing during childhood.

For educational purposes, since the passing of the Elementary Education (Defective and Epileptic) Act, 1899, epileptics have been grouped with the physically or mentally

the after-histories show that many, if not most, need care and supervision similar to that accorded by the Central Association for Mental Welfare to the mentally deficient.

[1] L. P. Clark, 'A Psychological Interpretation of Essential Epilepsy,' *Brain*, 1920, XLIII, p. 38. J. T. MacCurdy, 'A Clinical Study of Epileptic Deterioration,' *Psychiat. Bulletin*, 1916, IX, pp. 186 *et seq*. The theory here put forward may hold good of a few cases, but it is not generally accepted as holding good of the majority.

[2] *Loc. cit.*, pp. 36–7.

[3] The statement is found, for example, in W. B. Stoddart's well-known textbook on *Mind and Its Disorders*, p. 295. A similar pronouncement is attributed to Sir George Savage; and, like several traditional maxims that are still often cited, seems ultimately to have been handed down from Hippocrates: Hippocrates himself, however, gave a more accurate and specific prognosis. Dawson found no relation between the age at which the convulsions appeared (about 5½ years, on the average, in his groups) and the subsequent mental ratio.

defective. By the terms of the Education Act, 1921 (Section 55, 1 (*b*) A), local education authorities must ascertain what 'children, not being imbeciles or idiots, are unfit by reason of severe epilepsy to attend the ordinary elementary schools,' and must make suitable provision for their education either by establishing special schools or classes, certified by the Board of Education for defective and epileptic children, or by boarding out such children near such a class or school. If the authority is satisfied that the parent is not making suitable provision for the child at home, it may require the parent to send the child (if over 7) to such a class or school. Severe and chronic cases are usually sent to colonies, as much for the sake of others as for their own. Accordingly, in towns like London or Birmingham, clear cases of epilepsy should be extremely infrequent in the ordinary school.

Among the backward groups three children—all boys—were reported to have suffered from periodic seizures, the description of which—together with the personal and family history—afforded strong presumptive evidence of their epileptic character. Two were subsequently removed to a hospital for treatment. All were mild cases of *grand mal*—the fits generally occurring out of school, and very often at night. In these the backwardness appeared to be the irremediable outcome of the steady mental degeneration accompanying the condition. During examination, each displayed a typical slowness of mental reaction, with marked failures of memory and of motor promptitude. These features are characteristic of epileptic cases. Owing to the way in which their failures and successes are scattered up and down the scale, the mental age of such children is always difficult to determine by means of the usual intelligence tests. The boys just mentioned seemed but little below the borderline for 'dullness' in the technical sense ; certainly none was feebleminded.

In the control group one instance of *petit mal* was reported. But, on investigation, it seemed possible that the 'fits' were simple attacks of faintness or dizziness, due to weakness of vasomotor control, rather than true examples of minor epilepsy. In the Birmingham investigation five

cases of epilepsy were reported and as many as twelve instances suspected.

9. *Chorea.*—From the standpoint of frequency, chorea is a far more important disorder. Alike in London and in Birmingham, considering the comparatively small size of the groups examined, the number of mild choreic cases was unexpectedly high. Of these several had never been recognized as such, either by the teacher or by anyone else. In London the majority were found in the backward groups; at Birmingham, where special attention had already been drawn to such cases, the effects on school work were less obvious.

Chorea, or St. Vitus' dance, is now generally regarded as a rheumatic condition virtually confined to children of school age. It is usually insidious in its onset. Indeed, a gradual retrogression in the child's school work is often the earliest sign. His copybook is no longer neat and clean; his sums are full of slapdash errors; his spelling is careless and erratic. In oral work his thought processes become at times so disorganized and muddled that he makes the most foolish slips and gives the most ludicrous replies. His attention grows weaker and more fitful; he cannot concentrate, and so fails to remember.

With all this there goes an increasing amount of clumsiness and fidgeting. The child is always shuffling his feet; he seems unable to sit still; he spills or splashes the ink; he drops whatever he is carrying. His temper changes; and he gets cross, petulant, and irritable. From home there come stories of nightmares, fits of depression, spells of causeless crying, and occasionally outbreaks of violence.

At times a diagnosis can almost be guessed from the child's handwriting alone. In Figs. 4 and 5 I give two typical specimens. The characteristic signs can easily be picked out after a little close inspection. Perhaps the most salient feature is the child's inability to keep the letters on the line, so that the inexperienced teacher is tempted to suggest that there must be 'something wrong with the boy's sight.' What is really at fault is the control of his muscular movements: in spite of every effort, his hand jerks, as though impelled by some freakish spring. The size and particularly

the slope of the letters are highly irregular. They are badly spaced as well as badly aligned. The side motion of the wrist is usually excessive, but now and then inadequate; the result is a sprawling hand with occasionally crowded strokes. Sometimes the convulsive motion of the arm sweeps the nib completely off the page. Where the child lifts his pen from the paper at the end of a word, there is often an angular turn or a dragging stroke; and, when he puts it down again to begin a fresh letter, there is a queer little tremulous shake. The thin long strokes may quiver like finely undulating lines; and, where a smooth loop or turn should be made, there is often a couple of sharp angles. Some attempt at forcible control is indicated by an excessive and irregular thickening of the down-strokes. And all over the page there are blots, smudges, and corrections. At times, indeed, if the child is watched, it will be seen that he is adopting odd devices in the effort to guide his movements better: he not only grips the pen very rigidly, but may even try to steady the right thumb with the knuckles of his left hand.

After a week or so, the involuntary movements grow more and more marked. Frequently, the first little crisis comes at the dinner table at home, when the child is scolded for spilling his food or smashing a plate, or for the grimaces that he appears to be making. In mild cases it is principally the face and hands that are affected. When the child is called out for examination, he starts twisting his fingers, shrugging his shoulder, jerking his head, or twitching his lips and eyebrows. If his hand is gently held, the slighter spasms of the finer muscles can sometimes be felt before they are seen. In some there is a visible tremor of the fingers when the hands are outstretched; and usually the knee-jerks are exaggerated. The tongue may look thick and flabby; and when the child is asked to put it out, it shoots forward like a dart and vanishes as if pulled back by elastic.

The disease is most prevalent about the middle of the school period; and, at any rate in the senior classes, the sufferers are mainly girls. Among my backward cases, there were nearly four times as many choreic girls as choreic boys. The majority were thin, anæmic, ill-nourished girls of 11

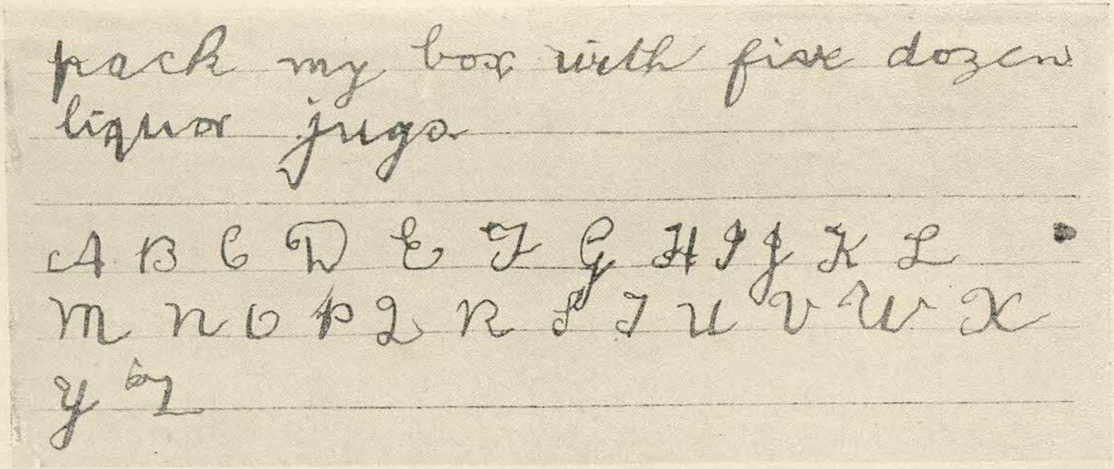


FIG. 4.—CHOREIC HANDWRITING.
1. Girl, aged $10\frac{8}{12}$. (Mental age, 13·1 years ; educational age, 11·4 years.)

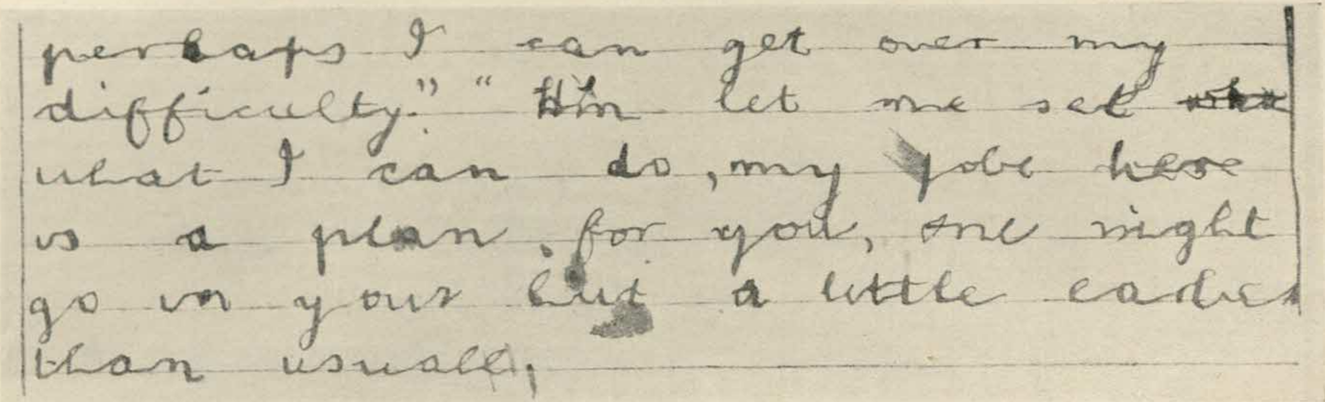

perhaps I can get over my
difficulty." "Then let me set what
what I can do, my jobe here
is a plan for you, one night
go in your but a little earlier
than usually,

Fig. 5.—Choreic Handwriting.
2. Girl, aged 11$\frac{2}{12}$. (Mental age, 10·6 years; educational age, 9·8 years.)

or 12, often sprouting up rather rapidly, sometimes chronically suffering from naso-pharyngeal catarrh, and continually ill with sore throats. Many complained of frequent 'stitch' or 'growing pains'—of petty aches in the muscles or joints, aches that seemed to shift from part to part, and were most severe during damp weather and the spring. In a large number of cases, particularly among those from the better classes, the child, and often his relatives as well, were of a neurotic type. In the majority, most of all in those from the poorer classes, there was a history of rheumatism, and in a few, by no means always the worst, definite signs of heart trouble. The significance of these attendant conditions becomes obvious when it is remembered that chorea has been described as literally a rheumatism of the brain. Rheumatism, as indeed the etymology of the word conveys, seems to manifest itself most typically as a liability to a chronic catarrhal inflammation of the mucous membranes—the linings of the joints, the eyeballs, the passages of the nose and throat—and of the connective tissues that envelop the muscles, the nerves, and the brain itself.

In London, cases of chorea, like those of rheumatism generally, are distributed very unevenly in different areas. In the damp low-lying districts just north or south of the Thames, and in streets near the courses of the old tributary rivers—the Hole Bourne, the Shore Ditch, the rivers Wandle and Effra—cases are singularly numerous. Southwark, Stepney, Poplar, and Greenwich report more than twice the proportion found in Wandsworth, Paddington, or Hampstead.[1]

Among backward pupils all degrees of the disorder are found. The children who give most trouble in the classroom are often mild cases that should perhaps be designated sub-choreic rather than diagnosed as downright examples of chorea. In such conditions, as in all states of nervous instability from whatever cause, any mental work calling for

[1] In a study of children suffering from acquired heart disease (rheumatic in origin) and attending special schools for the physically defective, my colleague, Dr. Shrubsall, has noted that comparatively few are found in those areas of London which lie more than 50 feet above sea-level.

steady application and attention is bound to deteriorate. Frequently, too, the child's backwardness is further aggravated by the long absences from school, since, particularly in the obstinate relapsing cases, exclusion is almost essential. In Birmingham my sister, Dr. Marion Burt, found that the average period of absence in cases of well-defined chorea amounted to 41·3 weeks in two years, and in minor cases to 29 weeks.[1]

About the treatment of chorea, much has been written; and the teacher must generally leave the matter in the hands of the medical officer. The severer cases will be removed to a hospital, the more refractory to a convalescent home, the milder perhaps to an open-air school, according to their individual needs. In the cases of latent chorea the teacher's co-operation will doubtless be required to shield the child from exposure to humidity and chill, from over-pressure at school work, and from every form of nervous strain. But probably the most valuable thing that he can do is to realize, and to convince others, that the child is not responsible for his instability and fidgetiness, and must be treated rather as a victim of his complaint than as a specimen of wilful naughtiness.

10. *Hyperthyroidism.*—Few cases of hyperthyroidism were noted in London, but a comparatively large number in Birmingham. Almost all of them were girls of 13, in the last year of school life. They usually exhibited a fullness or enlargement of the thyroid gland in the neck, together with one or more of the various symptoms currently associated with excessive thyroid activity—rapid pulse, fine tremor, quick and widespread flushing,[2] occasionally an

[1] *Report of the School Medical Officer for Birmingham*, 1923.

[2] In two cases, I was told by the headmistress that it was the excessive flushing that had led to the condition being noted and discovered. In a third case attention was called to the girl by the singular red marks she frequently showed on her neck and arms. It was first thought that the girl was a hysteric, and was trying to attract interest by self-caused 'eruptions.' The patterns, however, proved to be letters and geometrical or heart-shaped designs which one or two other pupils had produced on her skin with a finger-nail.

This susceptibility, which schoolfellows love to exploit—dermographia, to give it its learned name—appears to be one peculiar result of the excep-

overaction of the upper eyelid (giving the child a staring, wild expression), and, very rarely, an actual though slight exophthalmos. One or two—possibly more—were half-developed instances of exophthalmic goitre. The majority, no doubt, were temporary consequences of that disturbed functioning of the endocrine glands so common in girls about puberty. Several, suspiciously enough, had bad septic teeth and complained of digestive disturbance—possible sources of the trouble. Every one showed nervous irritability and mild emotional disorder—excitability, talkativeness, bad temper, speedy exhaustion, bouts of giggling, weeping, or worry, together with a general instability of character and attention—all of which made them difficult problems in the classroom, and greatly impeded their regular work. Their mistresses usually dubbed them 'hysterical.' A few were bright, imaginative young people, shining in oral and written composition, who passed for backward chiefly because of their carelessness or ignorance in the drearier and more formal subjects.

11. *Recurrent Headache.*—With other functional disorders I shall deal when I come to discuss the temperamental characteristics of the backward child, since they are really emotional disorders rather than nervous disorders in the stricter sense. Here, however, I may refer in passing to one particular trouble that was frequently reported in the backward cases, namely, headache. Teachers and still more parents often suppose that headache has some direct relation to headwork, and that the brain aches as a result of its own activities. Headache has innumerable causes, most of them originating outside the head. I touch upon it here, not merely because it is a common symptom in the nervous child, but because the nervous child is more easily upset by it than other children.

Where a pupil is continually afflicted with pain—whether headache, toothache, or earache—arithmetic is the subject that suffers most. Among the backward readers,

tional vasomotor reactivity of the hyperthyroid type. A 'trade-mark' (as the children themselves sometimes term it) can be written with the blunt end of a penholder on the naked back or forearm: in half a minute or so the writing stands out in red and white wheals.

however, recurrent headaches were also noted with some frequency. Here they seemed principally to occur in those who were troubled with defective sight, most of all in cases where astigmatism rather than simple myopia or simple hypermetropia was demonstrably present. Often the defect was comparatively mild, and had therefore remained uncorrected. But, generally speaking, to judge from the figures in the groups here studied, the commonest cause of recurrent headache in school children would seem to be rheumatic conditions rather than errors of refraction. As a rule, the headache associated with bad vision appears later in the day, after a long spell of bookwork or paperwork; while the headache of which the rheumatic child complains generally appears in the morning. Such complaints were mentioned quite frequently by the backward children, and were repeatedly found in conjunction with mild neurasthenic symptoms.

If the percentages and coefficients given in the tables can be trusted, there is no demonstrable relation between recurrent headache and general backwardness. On the other hand, those who were backward solely and specifically in reading, and (to a less extent) those who were backward solely and specifically in arithmetic, included a disproportionate number who complained of frequent headache: with specific backwardness of this kind, however, we are not concerned in this volume.[1]

12. *Heart and Lung Defects.*—More serious diseases can be passed over quite briefly. The graver affections of heart and lung do not produce backwardness, unless they necessitate repeated absence for long periods, or are attended by a general lowering of bodily vitality.

The figures for organic disease of the heart appear somewhat higher at Birmingham than at London: but the difference doubtless depends upon the number previously detected and already removed to special schools. The few showing valvular defects had histories of acute rheumatism and chorea. The remainder were cases of weakness or inefficiency of the heart muscle, often secondary to some toxic infection, such as that of diphtheria, scarlatina,

[1] Compare the figures given in the Birmingham report, *loc. cit.*, p. 13.

tonsillitis, or (most frequently) rheumatism. Several of the mild cardiac cases showed a curious variability in scholastic tests, when re-tested on successive occasions. Their treatment is manifestly a medical rather than an educational problem.

Under school conditions, a diagnosis of active tuberculosis is hardly possible; and only two cases of a definite kind were recorded in my groups. The general public displays a deep interest in tuberculosis during childhood: yet, at these ages, clearly developed cases appear to be far rarer than is ordinarily believed.

In the backward groups a history of lung trouble—bronchitis, pneumonia, or broncho-pneumonia—was common enough; and among these a substantial proportion had been previously noted as instances of suspected tuberculosis, or of a so-called 'pre-tubercular type.' Most of those who showed—or seemed to show—a tubercular predisposition belonged to one or other of the two familiar forms. One batch comprised a number of pretty, fair-haired children, slender but well-formed, with refined features, long eyelashes, silky hair often growing low down on the temples and cheek, and a delicate transparent skin revealing the blue veins beneath; many were of a somewhat neurotic, happy-go-lucky, sanguine temperament, neither very earnest nor very even in their classroom work, yet possessing distinct intellectual and even æsthetic gifts. The other type consisted of darker, heavier individuals, of squat figure and sallow complexion, with lips and nostrils thickened and congested, and lymphatic glands often enlarged; these were slower and more stolid at their lessons, but often proved far less obtuse than they outwardly seemed.

The suspicion of tubercle had usually been tentatively suggested by the school doctor at his first examination—in most instances, I fancy, on account of tubercular disease in the family or the home. The actual disorders most frequently reported, and possibly affecting scholastic work, were recurrent spells of lowered health, marked by a general lassitude and a quickened pulse, with nausea or loss of appetite in the mornings, slight fever in the evenings, and outbreaks of sweating during the night. A closer investiga-

tion of the cases occasionally indicated an infection of the glands—cervical, bronchial, or more rarely abdominal. More often than not, however, no evidence of actual tubercular trouble was found. Of the cases diagnosed as 'suspected tuberculosis' or possessing a 'tubercular diathesis,' those at Birmingham gave a fairly high correlation with backwardness, while those at London showed none. The discrepancy is no doubt very largely to be explained by the difference in the nature or severity of the conditions indicated by these vague labels.

13. *Zymotic Illnesses.*—There can be little question that the common infectious diseases of children—whooping cough, measles, mumps, scarlet fever, and the like—may at times definitely retard educational progress. Both in London and in Birmingham the total number of such illnesses was appreciably higher among the backward than among the normal.[1] What seemed especially significant was the large number of retarded children whose history revealed a long succession of such attacks; among the dull or backward the proportion who had suffered from four or more infectious ailments was nearly double as great as among the other children. A cumulative series of four, five, and even six feverish illnesses, besides inflicting repeated periods of prolonged absence from school, must often leave behind it a more or less permanent sequel, in the shape of reduced vitality or local trouble; and both in Birmingham and London an appreciable correlation was found between this feature of the child's medical history and his backwardness in school work.

14. *Hereditary Conditions.*—Were it possible, it would be

[1] The average number of such illnesses was, as shown on the medical cards and checked by inquiries from the parents, 2·5 among the backward and 2·1 among the normal. But percentages for zymotic diseases, unless obtained from a large and diversified sample, are bound to be unreliable. Epidemics, the varying ages, the lack of full information, all render figures from small groups untrustworthy. At Birmingham, a recent outbreak of measles in one of the girls' departments had enlarged the average in the normal control group; while, especially in the poorer schools, the requisite information was at times either unrecorded or demonstrably incomplete. In London, where interviews with the parents could be more easily arranged, the particulars were more accurately obtained.

interesting to determine how far the defects thus discovered rest on a hereditary basis. In collecting data for the family histories, I have always endeavoured to obtain notes upon the physical as well as the mental characteristics of the other members of the family. Of physical conditions that might be supposed to be inheritable, the only specific disorders mentioned with any frequency in the records are instances of tuberculosis, rheumatism, hyperthyroidism, epilepsy, and chorea. In a far larger number of cases, however, there were strong reasons to suspect that the dull child who was also an ill-developed weakling came of a stock possessing low physical vitality: this was very often noted in cases where the child was independently considered by the medical examiner to be suffering from malnutrition of a 'constitutional' type. But it is almost impossible to secure trustworthy evidence which would warrant treating this as an inheritable condition; and, even if inheritable, it is probably to a large extent remediable. Altogether, therefore, the information obtainable in regard to the inherited physical constitution of these children is too meagre and too unreliable to possess any genuine value. For the sake of completeness I have worked through the records, and have counted up the number of cases in which a physical condition that might reasonably be supposed to be inherited was recorded: the figures are given below in Table XV. Where general physical weakness has been noticed in other members of the family, and (so far as can be ascertained) cannot be explained by poverty or other domestic conditions, there, as the table indicates, the correlation with backwardness is distinctly high—one of the highest, indeed, in the list.

TABLE XV. HEREDITARY PHYSICAL CONDITIONS (LONDON)

	Normal.			Backward.			Coefficient of Correlation.
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	
Specific .	6·7	8·1	7·4	11·4	14·1	12·8	·16
General .	9·3	7·6	8·4	18·7	23·7	21·2	·32

Treatment.—These, then, are the main defects of health that might be supposed to contribute towards a child's educational backwardness. A glance at the list and at the figures in the table is sufficient to reveal one comforting conclusion, namely, that slight and remediable conditions are far commoner than grave or irremediable.

Among the groups investigated the following are the main conditions that may be classed as non-remediable, or nearly so: (i) deafness due to serious disease of the ear; (ii) defective vision due to corneal scars or serious disease of the fundus; (iii) graver cases of tubercular infection; (iv) graver cases of organic heart disease; (v) epilepsy. Taken together, these make up less than 8 per cent. of the total number in the backward group, and account for less than one-fifth of those cases in which backwardness seemed largely attributable to physical disorder.

In the remainder, the conditions found may, with scarcely any exception, be considered capable of remedy, or at any rate of relief. The following fall under this category: (i) malnutrition, with its numerous after-effects, particularly where the malnutrition is of a 'social' rather than a 'physiological' origin; (ii) the various acute zymotic infections with their after-effects, particularly where measures to prevent spreading can be adopted; (iii) more chronic conditions, where infection probably plays a part though its importance is not generally stressed, namely, the less obstinate tuberculous, rheumatic, and catarrhal infections; (iv) septic conditions of nose, throat, ears, teeth, glands, etc.; (v) hypertrophied tonsils and adenoids; (vi) defective hearing due either to the conditions just specified or to slighter affections of the ear; (vii) defective vision, due to errors of refraction; (viii) left-handedness and minor disorders of muscular control; (ix) chorea; (x) functional nervous disorders generally; (xi) defective speech. These conditions, it will be seen, account for over nine-tenths of the cases in which physical defects were observed.

From this review it is evident that with few exceptions the physical conditions that chiefly interfere with school progress are not so much well-defined or active diseases as generalized conditions sapping the child's physical and

mental vigour. And from what I have already said above it will be realized that no great increase in educational progress can, as a rule, be expected from medical or surgical measures alone. Occasionally, a spontaneous improvement may be noted, even with no special help or coaching; but such improvement is generally small and by no means universal; and in my experience it is wholly exceptional for physical treatment of itself to turn a backward pupil into an average scholar.

From the overlapping of the figures it can easily be seen that, in most individual cases, the adverse conditions must be multiple and complex. Hence single or simple remedies are usually unavailing. The defects we have hitherto examined appear to be so intimately associated, and so closely interdependent the one upon the other, that an attempt to relieve the most conspicuous trouble—excising tonsils, extracting teeth, or providing meals at school—does little more than palliate a superficial symptom. The real need is to investigate and (as far as may be) to remove the more general underlying causes. The commonest of these deeper causes apparently fall under one or other of three main headings: first, catarrhal conditions, affecting the respiratory and gastro-intestinal tracts, sometimes even the heart and nervous system, and leading to defective breathing, defective hearing, and a deficiency of stability and stamina; secondly, rachitic conditions, often accompanied by a partial arrest of physical and mental growth, and followed more particularly by defective formation of chest, palate, and nose, which in turn further weaken the child's health and physique as a whole; thirdly, an inherently defective vitality, retarding the development both of mind and of body, and due to some inadequacy either in the general metabolism and nutrition of the body or in the composition of the blood as determined by the secretions of the endocrine glands, or, it may be, to some vaguer and yet more primitive defect in the germ-plasm itself. Possibly these three groups may in turn be resolved into one—the first set of factors being frequently the sequel to the second, and the second the outcome of the third. All three conditions, as the histories so often show, seem closely related

to a state of malnutrition and weak health in early infancy—though how far such a state, when it exists, is a cause, and how far it is a sequel, would be difficult to say.

Thus, as seen in the schoolroom, the typical and the commonest case of all is one in which the child appears to be suffering, or to have suffered during his pre-school life, not from any single well-defined complaint, but from a plurality of minor troubles, all combining to manifest or to maintain a lowered state of bodily vitality. Hence the outstanding condition is what is often vaguely termed general debility, partly no doubt innate, and partly due to various post-natal and environmental conditions—poor feeding in early years, a series of minor infections, lack of proper nourishment or sleep, all aggravated perhaps by excessive worry and fatigue and the countless petty evils that obstruct a child's growth and undermine his energy in unwholesome and insanitary surroundings.

This means that not only medical but social measures are required. Physical defects are sufficiently numerous to make it desirable that every backward child should be medically examined, and that every backward class should be, directly or indirectly, under medical supervision; wherever necessary, too, medical or surgical treatment should be promptly applied. But, nearly always, it will be essential to follow up such treatment by suitable measures of general hygiene. This in turn will entail improving the home conditions. Where they cannot be improved, they must be supplemented by special care at school, or else the child must be temporarily removed from home to some healthier situation. A week or two in the country will seldom be enough; but six or twelve months in a rural school may effect a well-marked change for the better, mental no less than physical. Even then, all too frequently, the cases will relapse when they return to the old environment. Hence one of the greatest needs is the provision of open-air classes and camp schools where such children may make a lengthy stay. But, more than anything else, it is imperative to attack the matter at the earliest possible age. Social and medical remedies, if they are not commenced until the child has spent several years at school and

has already become notorious as a backward pupil or a 'problem-case,' will inevitably have to undo much that might have been successfully prevented by adequate precautions at the very outset of his life; and hence are never likely to be completely successful. Above all, the teacher must remember that, when the doctor or surgeon has done his best, special educational help must be given to enable the child to recover the ground he has lost and use his new mental energy to the utmost advantage.[1]

[1] The adoption of correlational methods for determining the reliability of medical assessments of health, nutrition, etc., has shown that these assessments generally have a comparatively low reliability (0·55 to 0·65). This is partly explained by the results of factorial methods applied to physical measurements, like height, leg-length, abdominal girth, weight, etc. The results clearly demonstrate that, contrary to the early statements of Spearman and other psychologists, a general factor is discoverable underlying physical growth, of much the same order as the general factor underlying mental development; they also confirm the existence of body-types, described by previous British and Italian writers, and subsequently popularized by Kretschmer (see Burt, *Man*, LXXII, 1944, pp. 82–6, and refs.). The conclusions drawn from measurements of school children have been amply verified by data obtained from several thousand men from the fighting services (cf. Banks, *loc. cit. sup.*, p. 74). During the recent war, considerable improvement has been made in the assessment of physical conditions: for example, owing to the inadequacy of the previous system of assigning 'medical categories,' the Canadian Army has introduced a so-called 'Pulhems' scheme (in which, as the initials indicate, Physique, Upper extremity, Leg, Hearing, Eyesight, Mental capacity, and Stability are separately assessed according to a graded scheme). It may be suggested that some of the new methods of examining and grading such characteristics might well be tried, and possibly adopted, by school medical officers for estimating the health and nutrition of school children.

As applied to physical measurements and pathological symptoms the methods and results of factor-analysis are still too controversial, and still too cumbersome, to be of direct practical value. The increased interest shown in factor-analysis since this volume first appeared may, however, quickly lead to agreed and simplified procedures. A suggestive field of work is the application of factor-analysis to growth-rates rather than to the mere results of growth: results with London children suggest that the tendencies towards this or that body-type are discernible long before the child comes to school, but that the adult form is due to differing growth-rates in different parts, especially at different developmental stages. What is most urgently needed, however, are factorial studies of development for the same children, carried out over a succession of years. Cf. Dearborn and Rothney, *Predicting the Child's Development*, 1941, published since this book was first issued, and *Proc. Roy. Soc. Med.*, XL, 1947, pp. 304–8.

CHAPTER VIII

SENSORY DEFECTS [1]

Sensory Defects as the Concern of the Teacher.—We now come to defects that are more specific in their nature and their consequences—defects of the senses and defects of movement. Weak sight, poor hearing, bad control of the hands and of the lips, these hamper the work of the class-room far more directly than a general weakness of bodily health; and it is these that the teacher should be able, more or less accurately, to detect for himself. It is natural to take them for consideration next, because their discovery and measurement ordinarily form part of the routine medical examination. Certainly, in a majority of cases, they arise, not as pathological abnormalities, but as perfectly normal variations in a normal but variable characteristic. Nevertheless, at times they form the symptoms or the sequels of definite and curable disease.

Strictly speaking, however, sensation and movement are mental capacities rather than physical; and individual differences in these respects are as much the business of the psychologist as of the doctor. To measure sensory acuity is to attempt a psychological measurement.[2] Hence it needs a psychological rather than a physiological train-

[1] I am greatly indebted to my colleagues Dr. R. J. Lythgoe and Dr. P. M. Kerridge for their kindness in reading the visual and the auditory sections respectively of this chapter, and for the generous way in which they have put their special knowledge and experience at my disposal.

[2] This, perhaps, is strictly true only of what might be termed *net* sensory efficiency: to assess the various contributing factors—the efficiency of the peripheral sensory mechanism (the retina, for example, in the case of the eye), the efficiency of the subsidiary apparatus (the refractive apparatus of the eye, for example), and so on—and thus to determine what specific physiological or pathological shortcomings are reducing net sensory efficiency in a particular person is a most complex task, and one which, as we shall see, demands all the skill of the experienced specialist.

ing; and, as carried out in the school, calls for a familiarity with children and their ways far more than for any special experience of bodily diseases or disorders. In my view, therefore, the initial tests at any rate should be conducted by the classroom teacher rather than by a visiting doctor or nurse. In America and in certain schools in this country, that is already the practice; and our own teachers would greatly benefit, if systematic instruction on the necessary psychological technique were embodied in the training college curriculum.

A. Defective Vision

Tests of Visual Acuity.—Man is a creature that lives by his eyes. He relies more upon vision than upon any other of his senses. To learn about the world he has entered, he either looks at that world, or else looks at descriptions of it, set forth on the printed page. If, then, our knowledge of the things around us is so closely dependent upon our power to see, what a handicap must be imposed upon the growing child by any impairment that affects the eye. Sight, therefore, should be the first of the senses to be examined in studying the backward and the dull.

Every teacher may learn how to make a first rough test.[1] He can, of course, only sift out suspected cases: the final examination and prescription must be left to the medical specialist with a proper training in this field of work. As it is, most teachers have but a dim and hazy notion of the visual difficulties to be met with among school children; and few understand the simpler methods that can be used for detecting them, or the precise way in which such handicaps impede the child's progress, or how they should be dealt with in the classroom. A word or two is therefore necessary upon these points.

[1] Here I am fully in accord with the remarks of Professor Terman. "The tests may and ought to be made by every teacher and the results carefully recorded for use. . . . Oculists of the highest standing have long contended that the ordinary routine examinations of the eyes should be undertaken by teachers. The teacher can make the tests fully as well as can the physician who is not also an oculist; and by virtue of her constant opportunity to observe the symptoms of eye-strain among her pupils she is in even better position than the school doctor to single out the children who need to be referred to an oculist." (*The Hygiene of the School Child*, pp. 269–70.)

Visual impairment may be caused, first, by some past or present disease of the eye itself—for example, by early inflammation or ulceration which may have left the cornea permanently scarred, or again by some disorder, possibly progressive, which may affect the retina, the optic nerve, or even the brain; secondly and more frequently, by some error of refraction—that is, by some imperfection in the focusing apparatus of the eye. A simple preliminary test is often suggested to discriminate between the two. The child is told to look through a pinhole in a thin black card; if his vision is thereby improved and objects seem clearer, then the sole cause of indistinctness is presumably some error of refraction. Disease, or the results of disease, are, of course, the special concern of the doctor; and an actual affection of the optic nerve or retina can be diagnosed only by expert and systematic investigation, which will include a thorough examination of the eye in the dark room with the ophthalmoscope.

The effects of defective refraction are relatively simple. Its immediate consequence is merely to throw the eye out of focus. This may happen in three ways. The differences are so important in the classroom that I may be pardoned for entering on a brief and elementary explanation.

(1) If the eyeball is too long, or (what amounts to the same thing) if the curvature of its lens and refracting surfaces is too strong, the result is *myopia* or 'short sight.' A myopic eye can see objects near at hand quite clearly, but objects that are only a few yards away may look misty and confused: they will have, in fact, the appearance of the blurred picture seen on the ground-glass screen of a camera when set too far behind the lens. The defect is corrected by wearing an artificial lens of glass before each eye; for myopia the lens must be concave, that is, more or less hollowed out according to the degree of the defect.

(2) If the eyeball is too short or its curvatures too weak, the result is *hypermetropia* or 'long sight.' Objects that are far away can be seen clearly enough (at any rate, in all except the severest cases); but objects near the eye—the letters on a printed page, for example—cannot be sharply focused unless a special internal adjustment is made. The eye

possesses an adjustable lens of its own; and the focusing power of this lens can be strengthened by muscular effort. Hence this particular defect can be temporarily overcome without external aid, and so may pass unnoticed. If prolonged, however, the effort induces strain.

In older persons the lens begins appreciably to lose its elasticity, and the curvatures themselves become weaker. The apparent hypermetropia that ensues towards the age of 45 or 50 is accordingly termed presbyopia, that is, old man's sight; everyone knows how the elderly tend to hold their books at arm's length and are sometimes quite unable to decipher fine print. The very young have much the same difficulty, since, up to the age of about 8 or 9, a slight degree of hypermetropia is normal and indeed almost universal; but, owing to the wide range of accommodation which they still possess, they are nevertheless able, with an effort, to focus near objects tolerably well. As the eyeball grows, the child's long-sightedness gradually diminishes, and ultimately, as a rule, disappears. Both in old and young, hypermetropia can be corrected by wearing spectacles with convex or bulging lenses, like the 'magnifying glasses' of our grandmothers.

(3) There is a third defect that often coexists with the other two—*astigmatism.* The lens, or rather in most cases the cornea, is more strongly curved in one direction than in another. This means that, when the eye is clearly focused for lines running one way, perpendicularly, let us say, it is not focused for lines running at right angles, for example, horizontally. Thus the child may be able to read quite easily the vertical figures on a clock-face, like XII and VI; but the horizontal figures, like III and IX, may appear smudged. No amount of spontaneous focusing can get rid of this inequality; it is, therefore, one of the commonest causes of eye-strain. It can be corrected by lenses that are slightly cylindrical.

If proper spectacles have already been provided, the teacher can infer the nature of a child's defect by looking at the lenses: if, held a few inches above a page of print, the glass magnifies the letters, the lens is convex and the eye has presumably been diagnosed as hypermetropic (or long-sighted); if the lens makes the letters look smaller, it

is concave and the eye myopic (or short-sighted) ; if the letters change their size and shape as the lens is rotated like a wheel, the eye is astigmatic.

To detect visual defects in the schoolroom, the test most generally employed is the familiar letter-card. This is primarily a test of distant vision, and is therefore used to discover and measure cases of short sight. On the ordinary charts, devised by Snellen and usually called by his name, large square letters are printed so as to be just legible by a normal eye at 60, 36, 24, 18, 12, 9, and 6 metres, respectively. The child stands at 6 metres (about 20 feet) from the chart. He reads out the letters first with one eye, then with the other—the unused eye being covered with a card, not shut or held tight with three fingers over the lid. If his eye is normal or ' emmetropic,' he should read all the letters correctly ; if it is short-sighted or ' myopic,' he will fail when he comes to the smaller letters. The test is continued until he reaches a line at which he makes two mistakes out of ten. The visual acuity of either eye is then measured by the fraction $V = \frac{d}{D}$, *i.e.* $\text{Vision} = \frac{\text{Actual distance}}{\text{Normal distance}}$, ' actual distance ' meaning the distance at which the child is standing (*i.e.* 6 metres, unless the child is so short-sighted that he can read nothing without going closer), and ' normal distance ' meaning the distance at which a person with normal sight could read the line of letters over which the child is just beginning to stumble. If, for example, the child can only read as far as the last line but two, his visual acuity is taken as $\frac{6}{12}$ or half[1] the normal, since this line (marked D = 12) should be read by a normal eye at 12 metres.[2]

[1] The meaning of this fraction must not be pressed too far. It may roughly be said that, if a child with $\frac{6}{6}$ vision can just read the blackboard at 6 yards, then a child with $\frac{6}{12}$ vision will need to be 3 yards from the board to read the same figures with equal ease. According to the table drawn up by the House of Delegates of the American Medical Association, the fraction representing visual acuity as measured by tests is smaller than the percentage that would express actual visual efficiency as a true ratio of the normal: thus, for a visual acuity of $\frac{6}{12}$, the visual efficiency is stated to be about 80 per cent. of the normal.

[2] Defects of refraction are sometimes recorded in terms of the refractive power of the lenses required to correct them. The unit of refractive power

For practical purposes, the working vision of the child may be taken as determined by that of his better eye. It is convenient to recognize two grades of defect: (i) 'slight' defects—that is, cases where vision with the better eye is only $\frac{6}{12}$ to $\frac{6}{9}$; (ii) 'marked' defects—that is, cases where with the better eye vision is worse than $\frac{6}{12}$. Roughly speaking, this picks out those whose binocular vision is (i) rather more than half the normal, and (ii) decidedly less than half, respectively.

Since, as we have seen, the measurement of visual acuity, as of every form of sensory capacity, is in its essence a psychological test, it cannot be carried out with scientific accuracy, unless the examiner is familiar with the psychological as well as with the ophthalmological technique. In children the psychical factors—timidity, a tendency to guess, familiarity or unfamiliarity with letters and their names and meanings, not to mention a mass of subtler influences—may be of crucial importance. It is, no doubt, in part the neglect of these psychical factors that has led to the incredibly discrepant figures to be found in the annual reports of school medical officers from various parts of the country: thus, to take an official review of the results, we find Tynemouth reporting 89·1 per cent. of its scholars as having V (for right eye) $= \frac{6}{6}$, while Blackburn reports only 30·6 per cent.[1] The younger and the duller the child, the more important are these irrelevant influences; so that the visual acuity of the

is called a dioptre. The dioptric strength of a lens $= \pm \frac{1}{\text{focal length in metres}}$. The plus and minus signs indicate convex and concave lenses respectively. Teachers often inquire what precisely, in practical terms, the need for a lens of so many dioptres actually means. Approximately it may be said that 100 divided by the number of (minus) dioptres will give the greatest distance (in centimetres) at which the myopic child can read small type—a 6-point nonpareil. Where the myopia is marked, the number of dioptres may be taken as inversely proportional to about three times the fraction measuring visual acuity: thus, very roughly, $-0{\cdot}5\ D = \frac{6}{9}\ V$; $-1{\cdot}0\ D = \frac{6}{18}\ V$; $-5{\cdot}0\ D = \frac{4}{60}\ V$; $-10{\cdot}0\ D = \frac{2}{60}\ V$. The lenses are generally prescribed after a direct examination of the eye in a dark room, checked by trying the lenses proposed to see if they improve the patient's reading of the letter-test.

[1] *Annual Report of the Chief Medical Officer of the Board of Education*, 1911, p. 38.

young and of the backward is very liable to be erroneously assessed.[1]

The letter-test, in the form just described, is in theory a test of distant vision only: in practice, however, it often serves to indicate the presence of other defects. Properly to test near vision, and to detect those who are predominantly long-sighted or 'hypermetropic,' is a more complicated task, owing to the reflex adjustments made automatically

[1] Since the testing of visual acuity offers special difficulties with the dull, and since the effect of these difficulties is so often overlooked by an inexperienced examiner, I may perhaps usefully append a footnote on the commoner pitfalls and the simpler methods of avoiding them. First of all, I may observe that, as with almost every test, the 'personal equation' introduced by different examiners plays an unusually large part in examining the dull. It often happens that a dull child is tested and re-tested by different doctors, different nurses, or different teachers; the discrepancies are sometimes astonishing. At the same time it must be remembered that acuity of vision is itself a variable function, and may alter in one and the same child from hour to hour and from day to day: this is a further reason for placing the first examination in the hands of the teacher. Nevertheless, the teacher has disadvantages of his own to contend with: the child may imagine that the test is a test of reading for which he may be scolded or blamed; and some teachers, from their ingrained tendency to rebuke or instruct, may throw the child into an emotional state which is even more confusing than the apprehensions aroused by a strange doctor or nurse. It is often instructive to re-test the younger cases, offering the child a penny for every extra letter he can read. Beside these emotional factors, mental, physical, and ocular fatigue have a profound effect on the results. Variations in the illumination of the card, and the presence of illuminants or bright objects near by, are complicating influences that are frequently overlooked by the untrained examiner. Duller children are less likely to compensate or allow for these irrelevant factors. It should also be noted that on the ordinary Snellen card different letters have different legibility, quite apart from their size; and, on the cards obtained even from the best commercial firms, the test-types, when measured, often prove to vary in size by as much as 10 per cent. Again, as the teacher will easily realize, the rarer letters, like J and Z, are harder for the young or backward child to name correctly, particularly if he has been taught, not their alphabetic names, but only their sounds. The lower lines on the test-card contain several letters in a row; and many, who do not grasp the purpose of the test, try to make words out of what they see. With such children all the letters except one should be covered by a screen containing a circular hole: this further aids the child's attention. Or, instead of using the ordinary chart with different letters which have to be recognized and read, a card containing a letter E only may be employed: the letter is turned (or, better still, is capable of rotation) in different directions: and the child has nothing to read, being required merely to indicate the direction of the E with his

by the lens. For exact purposes some other form of ophthalmological examination is therefore necessary: but a thorough testing of near vision is seldom undertaken in the school. For ordinary purposes it is sufficient to use a test depending on the power to read small print. Test-cards have been devised by Professor Jaeger consisting of a few lines of reading matter set up in type of graduated sizes. The cards are obtainable from most opticians.[1] The

fingers. Even here, however, the problem of orientation may be confusing to some: a few children, for example, will imagine themselves in the position of the chart and so produce mirror images of the directions they see. Accordingly, the very young and the very backward child will still need a little preliminary training. For the youngest and most illiterate of all, picture-tests have been devised. Of these perhaps the best is McCallie's 'visual test for illiterates': the test is presented as a game, and turns upon the perception of a dot in a circle.

The recognition of letters or pictures depends essentially on the active co-operation of the patient. With the very young or dull, a more objective method is preferable. Hence for the accurate diagnosis of visual defects every doctor who examines school children should be a master of the art of retinoscopy. When such innumerable difficulties hinder the measurement of so simple a capacity as vision, the teacher will easily understand what an extremely precarious task it must be to measure the higher capacities of the mind.

[1] Jaeger's test-cards are numbered J 1 to J 20. J 1, the smallest, corresponds approximately to what the printer calls 'Diamond' type; it is the smallest type seen in this country, and has a face for small letters that is about 0·02 inch high. It should be read by a normal eye at about one-third of a metre. Nonpareil (6 point, generally used for newspaper advertisements) and Minion (7 point, generally used for the text of newspapers), which correspond approximately to J 6 and 7, should be read at about 1 metre, or rather more.

If all the type designated by a given name were of uniform style and size, any ordinary passage in small print might serve. Unfortunately there is much confusion over the printer's nomenclature. Not only does the terminology vary, but the same name is given to types of different sizes by different founders. All this is very perplexing to the teacher who, in ordering textbooks for his class, has to consider what kind of type is suitable. The printer is more interested in knowing the height of the *body* of the type; psychologists, educationists, and ophthalmologists only in its printed *face*. In this country and America the unit measuring the body of types is the 'pica'; this is supposed to be approximately $\frac{1}{6}$ inch high (now standardized at 0·166044 inch: Parliamentary reports are usually printed in pica). The pica is divided into 12 'points'; and thus a point should be about $\frac{1}{72}$ inch. The French point—or 'Didot point'—is slightly larger than the English, 0·0148 inch instead of 0·01387 inch. Since the point system is intended to

moderately hypermetropic can manage the smaller types after an effort of accommodation, usually involving a slight but appreciable delay ; often they can read such type far better at a greater distance. Those who are extremely hypermetropic cannot read the tiniest types at all. Even with the ordinary Snellen letter-chart they frequently make similar hesitations and errors : but here they will occasionally read the smaller letters more readily than the normal person ; and, when a weak convex lens has been placed before the eye, they can still read $\frac{6}{6}$, perhaps with greater ease than before ; for the normal child, of course, the interposition of such a lens would be not a help but a hindrance. Contrary to the common notion, no matter what the defect be, it is rarely a safe method simply to allow the patient to state which glass he can see best with ; and in dealing with hypermetropic children of school age the oculist nearly always finds it necessary, before prescribing spectacles, to paralyse the muscles of the lens first with atropine.

To test astigmatism, a chart consisting of lines radiating from a centre, like spokes from a wheel, is generally used. With children I find it better to use reproductions of letters, geometrical figures, or simple objects, made up of thick parallel lines or stripes—vertical in one case, horizontal in another, slanting to the right or left in others.[1] If carefully

measure only the body of the type, it gives but a rough notion of the size of the face : as a rule, the body of the type is nearly three times as high as the face of a small letter.

Owing partly to the diminishing hypermetropia of the average child, it is generally agreed that print should be larger the younger the child. For school books psychological investigators recommend that the minimum height of the face of small letters should be about $\frac{1}{16}$ inch for children over 12 (say 11 to 14 point), and twice as high for children under 7 (at least 24 point), with intermediate sizes for the intermediate ages. The text of this page is printed in 12 point (pica), and this footnote in 10 point (long primer) : these correspond roughly to J 10 and J 8, and should be legible to a normal child of 14 at about 1·5 and 1·25 metres respectively. The acuity of the eyes is not the only factor to be considered, however. Hence, for backward readers I usually recommend that the size of type should be that suited for an age midway between the child's physical age and his mental age for reading. (See *Brit. Ass. Report of Committee on School Books and Eyesight*, 1913, and *Medical Research Council Report on Legibility of Print*, 1926.)

[1] Pray's striped letter-tests, obtainable from most opticians, are convenient for this purpose.

printed, the objects all seem equally dark to the normal eye; but to the astigmatic eye some seem blacker than others.

The existence of hypermetropia and astigmatism can often be guessed from minor symptoms and peculiarities, which every teacher should be alert to observe in the course of the ordinary work of the classroom, particularly during near work like reading, writing, or sewing. The chief indications are the following. First of all, the child himself will constantly complain that letters, stitches, and other objects, appear foggy or indistinct: they seem to 'run together,' and 'look jumbled up'; or he will sometimes say: 'I see two edges close together instead of one.' Often the complaint is expressly limited to the lesson which the child finds hard. Or again, when trying to read or write, he will adopt some eccentric posture, twisting his head or leaning it on one side: or he may hold his book or paper at an unusual distance from his face or at a peculiar angle. He may contract a habit of peering or frowning when trying to fix an object with his eyes, and will frequently evince a marked distaste for all close work. There may be local symptoms, such as redness or soreness of the eyes or eyelids, constant watering, and spasmodic blinking or winking. He may complain that his eyes ache, itch, or smart, or that he feels a pain in his eyeballs, or in his forehead just over the eyes. Not uncommonly there are more general symptoms as well—a vague headache, an undue tiredness, slight spells of dizziness or giddiness, and the like. Indeed, the ultimate effect of eye-strain is often to undermine health altogether, and produce a state of mild neurasthenia.[1]

[1] With the problems of defective colour vision I have not dealt here, since it plays little part in the causation of educational backwardness. Nevertheless, as I have urged in previous reports, colour tests (*e.g.* the Ishihara) should be systematically applied by teachers, since such defects are far commoner than is supposed, and not only cause inconvenience in school work, but require urgent consideration in vocational guidance for school leavers (cf. M. Collins, *Colour Blindness*, p. 221). In my school surveys I have relied chiefly on Stilling's pseudo-isochromatic charts, supplemented by wool, bead, speed, and distance tests. I find over 3·1 per cent. of the boys and 0·2 per cent. of the girls suffering from defects sufficiently pronounced to be regarded as 'partial colour-blindness.' About half were 'deuteranopic,' and about one-third 'protanopic.' Another 3 per cent. of the boys and nearly 1 per cent. of the

Incidence of Visual Defects among the Backward.—As a check upon the figures recorded on the medical cards, and to preserve a similarity of standard, the vision of every child in the investigations I am describing was specially tested. The examiner for the backward was the same as for the children in the corresponding control group—Dr. Lloyd in Birmingham, and myself or one of my senior research students in London. Reliance was placed chiefly on the three tests just mentioned; and the children were classified as explained above. In addition, a close watch was kept for other defects, whether of refraction or of the internal or external parts of the organ, which would not be revealed by these simple test-methods. In a few cases the children were further examined with the retinoscope or ophthalmoscope and with the Maddox rod-test for heterophoria.

Among the groups here investigated I found only a single case of serious disease—a London girl in the backward group showing hazy scars on corneæ that permanently obscured her vision: these were associated with other symptoms suggestive of a specific infection in infancy. For the rest the defects recorded or observed consisted chiefly of the usual errors of refraction—myopia, hypermetropia, and astigmatism—together with external or surface inflammations. The two were often found in the same child, and in a few cases were complicated by a squint. The percentages noted among the normal, backward, and mentally deficient groups respectively are given in Tables XIII and XIV (pp. 165–6 above).

(i) *Defects of Refraction.*—Marked errors of refraction were found in nearly one-fifth of the backward cases.

girls showed specific weaknesses with threshold tests, or anomalies (chiefly 'deuteranomalies') with colour-mixture tests. The total amount of defective colour vision of all varieties among the male population must thus be not far short of 8 to 10 per cent. Surveys carried out elsewhere revealed slight regional differences, the proportions increasing from East to West and North to South: this corresponds with the geographical distribution of eye- and hair-colour; and a small correlation (about 0·20) was found with pigmentation, not unlike that recorded in investigations on primitive races. On methods of testing, see Whipple, *loc. cit. sup.*; also *Journal of the Optical Society of America*, XXXIII (1943), 'Symposium on Colourblindness.'

Slight defects were still more numerous ; but these, particularly at Birmingham, were surprisingly prevalent among the normal. Consequently, the correlation of backwardness with these slighter defects, though positive, was here barely significant. The correlation with marked defects, both in London and in Birmingham, was definitely significant but small. In London 3 per cent. of the backward had a myopia of — 3 dioptres or worse, as compared with 1·5 per cent. of the normal. As usual, defects of refraction were found rather more frequently among the girls than among the boys, the figures being roughly in the proportion of about 5 to 4.

In the course of my regular work, I have been struck with the existence, not only of slight sex-differences, but also of slight race-differences. It is a familiar fact that myopia is commoner among Jewish adults than among non-Jewish. Analogous differences are noticeable among Jewish children. I find that, as perhaps might have been expected, a noticeable excess in myopia does not appear until the later ages ; but at all ages hypermetropia seems distinctly rarer. It is tempting to suggest that this may be one of the chief reasons why backwardness in reading is so much less frequent among Jewish pupils.[1]

The differences between the different age-groups were of the usual kind : more hypermetropia in the younger and more myopia in the older. The change was most evident in the case of the milder defects, no doubt because these were more numerous. Among the backward the com-

[1] See below, p. 462. In Jews, the excessive tendency to myopia becomes very pronounced among the older boys, so much so, indeed, that the usual sex-difference is almost obliterated. The race-difference might readily be explained by supposing that the Jewish child starts with a smaller reserve of hypermetropia in infancy. If his eye were emmetropic at the outset, and the same change takes place in him as in other children, this would naturally lead to a greater frequency of myopia. It is tempting to speculate whether the rarity of hypermetropia is itself the effect of a kind of natural selection. Before the invention of spectacles, the Jew whose living depended upon his ability to keep accounts and read them, would have been incapacitated by the age of fifty, had he possessed the usual tendency to hypermetropia : on the other hand (as I can personally testify) the myope, even with a moderate amount of presbyopia, can dispense with glasses for near work without much loss of efficiency.

monest type of defect was that of the young child showing a mild degree of hypermetropia, generally accompanied by slight astigmatism.

I have already commented on the fact that among the younger children—those just learning to read and write—hypermetropia is far more usual than myopia.[1] Teachers are prone to assume that defective vision means simply short sight—inability to see objects at a distance. On the contrary, during the earlier years of school life, the pupil who has a difficulty in seeing fine print close to his eyes is much commoner than the pupil who sees nothing but white smudges upon the distant blackboard; and he labours under a greater disadvantage in the typical work of the schoolroom—in dealing with reading-books and figures on paper, in handwriting, drawing, needlework, and wherever near vision is required. By an effort of focusing he can overcome the difficulty, at all events for a few minutes; and so, as we have seen, it is apt to pass unnoticed. As a result, the very defects which most seriously hamper school work—hypermetropia and the astigmatism which so often complicates it—are the defects most likely to be missed, particularly if the examination of the eyes is limited to the ordinary letter-test. Nevertheless, the child labours under a constant strain; and the strain may quickly result in aching eyes, an aching head, and a vague unanalysed dislike for all that occasions such discomforts.

Defects of this sort, therefore, especially with backward children, must be carefully watched for, even in the infants' department. It is there that the child is first using his eyes to read; and, as my data amply reveal, a marked backwardness in reading is one of the commonest results of this early neglect. Among older children short sight becomes more prevalent; and, with these, the most obvious consequence—but by no means the most important—is a backwardness in arithmetic, arising from sheer inability to see the blackboard. Short sight, however, is more regularly detected; and untoward results are consequently rarer.[2]

[1] See above, p. 211; also Bishop Harman, *Report of Ophthalmological Congress*, 1919, and Kelynack, *Defective Children*, p. 178.

[2] In the majority of cases (roughly assessed at about 95 per cent. of those

Treatment.—The tables printed above show that of the visual defects discovered among school children the majority are comparatively slight. Even the more serious seldom become an important cause of backwardness, unless they have escaped both detection and correction. With a few obvious precautions in the severer cases, such children can usually attempt the regular work of the ordinary classroom. At their worst they should be noted for easy treatment as regards eye-work—allowed to sit in the front row, with their reading and their writing confined to twenty-minute periods with large type and bold letters. For girls, knitting is better than sewing: knitting can be done almost automatically by touch and muscle-sense; sewing demands a fixed concentration with the eyes. To the myopic, reading from the blackboard is often far more trying than reading from books. For such children nothing is so distressing as copying sums chalked up by the teacher, when first the distant board and then the paper on the desk have to be focused and re-focused in turn. Time and trouble might well be saved if the sums were given to the pupils on clearly hectographed sheets, and only the solutions had to be written out by the child.

But, no matter what may be the degree and nature of the defect, directly the child shows those characteristic signs of discomfort and distaste for lessons that are associated with eye-strain, he should not be pressed or scolded, but relieved. Trouble of this sort, however temporary, will tend to make the child resent all intellectual effort, and so become more backward than ever. When spectacles have been supplied, he may at first need a little practice and encouragement in their use, especially if the lenses are strong and the correction has been delayed. Teachers should see that the lenses are

leaving school with a definite visual defect), the impairment of vision, though it may seem at first to be progressive, causes little inconvenience apart from the necessity for wearing spectacles. In rarer cases, sometimes described as 'progressive myopia'—or better perhaps as 'pathological myopia,' the disease usually appears first during the early school period, and progresses at the rate of one or more dioptres of myopia per annum. Unfortunately, not enough is at present known either of the causes or of the course of the condition to enable an early differentiation to be made between the 'physiological' and the 'pathological' types with any degree of certainty.

kept clean and the frames straight. To peer through greasy glasses, skewed so that the eyes look through the sides instead of the centres, is often more trying than discarding glasses altogether.

In the backward groups examined at London and at Birmingham I found no instances of really serious visual defect: with the provision already made in those areas by the education authorities, it was hardly to be anticipated that any grave cases would be discovered at the ordinary schools. In other areas, however, where I have carried out tests on backward children, such cases have been from time to time encountered; and it seems evident that the arrangements made for dealing with them still leave much to be desired. I may therefore briefly summarize the advice that I have generally put forward.

Children whose vision is worse than 15 dioptres,[1] or whose vision cannot be corrected with glasses up to at least $\frac{6}{24}$, are unsuitable for instruction in the ordinary class. At present, where some provision has been attempted, they are often transferred to special schools such as those unhappily named schools for the 'partially blind.' A number are even to be found in schools for the totally blind.

With the 'partially blind' the methods adopted for the totally blind are certainly to some extent helpful. But the important characteristic of these children is not that they are partly blind but that they are partly sighted. A psychologist is bound to insist on the injurious mental effects which must inevitably follow from a policy that segregates such children from their fellows and emphasizes their defects and shortcomings instead of their positive abilities. Here, as so often, our philanthropic efforts to help the child who is defective physically end by doing more harm than good, because, even when they arrest the physical trouble, they produce a mental trouble that is still more injurious. Accordingly, schools or classes for the partly sighted should never be associated, even by proximity, with schools or institutions for the blind.

The ideal plan, which might be adopted more freely in populous areas, is to attach a special sight-saving class to an

[1] See footnote 2, pp. 212–13.

ordinary school. Children should be transferred not later than the age of 7; and relatively mild cases could then be accepted that might otherwise go to a school for the partly blind. Where this is not practicable, I suggest that a large proportion might be accommodated in the special classes for backward children. With them as with the backward, hand-work should take the place of eye-work.[1] Yet they should not (as so often happens) be altogether discouraged from trying to read and write, but taught to do so with a judicious expenditure of effort and time. Instead of the usual school desks the younger should have tip-up blackboards on which they can write in free-arm fashion; the older might learn to use the typewriter. Left to himself a child of this kind will generally tend to peer and grope; and in an ordinary school the fear is often expressed that the remainder of the class may tend to copy his grimaces or mimic his odd ways. Such fears are exaggerated; and the tendency itself is a reason, not for segregating the child, but for training him to mix with his fellows without making himself painfully eccentric.

Children with less serious defects, ranging, say, from about 5 to 15 dioptres, will usually have to remain in the ordinary school; but they should be marked for oral teaching mainly—particularly if the defect appears progressive and incapable of reasonable correction by glasses. Most of them seem to comprise either hereditary cases with a definite history of myopia in their families, or cases in which the eye itself has been injured by accident or its tissues impaired by inflammation. For all subjects that can be taught without bookwork or paperwork, they can participate in the daily routine of the ordinary classroom. They will thus escape any stigma, or any depressing sense of their own peculiarity; and, at the same time, they will gain greatly from continued association with their normal fellows. These slighter cases should only be moved to a backward class if seriously backward in academic work.

[1] For a detailed description of the methods desirable in such classes, see Bishop Harman, *Brit. Med. Journ.*, II (1910), p. 1320, and *School Hygiene*, I (1919); also *Report upon Partially Sighted Children* (H.M.S.O., 1934).

(ii) *Colour Blindness.*—Of the backward boys, 4·8 per cent. suffered from one or other of the common types of red-green blindness; but among those who were not backward the proportion was almost the same. No cases were found among the girls. All teachers should be told during their training period that unrecognized defects and anomalies of colour vision are far commoner among the male population than is generally supposed, and that confusion over colours is in no way indicative of subnormal intelligence.[1]

(iii) *External Defects.*—The incidental discomforts of the weak-sighted, particularly of those who suffer from undetected hypermetropia or astigmatism, are often aggravated by some minor disease of the outer tissues of the eye. External defects of this kind were observed in rather over 5 per cent. of my backward cases. By far the commonest complaints were blepharitis and conjunctivitis—inflammation of the outer or inner surface of the eyelids, sometimes involving the surface of the eyeball.

Treatment.—These petty ailments are so widespread, so contagious, and so irritating to the child, that the teacher should know how to detect and deal with them. Few troubles make the essential work of the classroom so painful.

Blepharitis starts usually with some difficulty in seeing clearly; the child's eyes feel tired and sore; he rubs them

[1] Cf. R. Brown, 'An Investigation of the Colour Vision of School Children,' *Brit. J. Educ. Psychol.*, XXI, 1951, pp. 150–3. The proportions vary appreciably in different parts of the country (cf. Burt, *Man*, XLV, 1945, pp. 103–6; *Eugen. Rev.*, XXXVII, 1946, pp. 149–50). Defective colour vision may become of practical importance in considering the school leaver's future occupation; it is of theoretical interest owing to the light it throws on the inheritance of mental differences. It was one of the earliest examples of Mendelian heredity recognized in man (cf. Burt, *Eugen. Rev.*, IV, 1912, pp. 1–33 and refs.). It generally appears as a recessive sex-linked characteristic; but its frequency among girls, slight though it is (0·6 per cent. in London), is nevertheless so large as to imply that, in many instances at least, the gene cannot be perfectly recessive. Not infrequently, indeed, heterozygous females are also affected, though usually in a milder degree. The fact that even here dominance is far from perfect warns the geneticist not to assume perfect dominance in his speculations about the inheritance of intelligence. See also R. W. Pickford, *Individual Differences in Colour Vision*, 1951.

with his soiled fingers, and so infects them. At the earliest stages the eyes look a little tearful, and the child seems hypersensitive to light. Presently there may be seen a slight, dry, bran-like secretion, fixed to the lashes, like tiny ragged papers skewered on a diminutive file. Later the lids get tender, and look swollen and red. Eventually the inflammation spreads; the lashes drop out; the eyelid pouts; and the eye that first looked weak now looks wet and altogether sore and unsightly. With continual rubbing the child re-infects his fingers, and then his pencils and pens; and these, passing into the hands of others, may infect fresh pupils in their turn.

With a little vigilance all this may generally be checked at the commencement; and the teacher should strive his best to prevent the mischief being handed on. So soon as the trouble is noticed, the child should be temporarily released from all paper and pencil work; his fingers kept scrupulously clean; his (or her) hair kept short; and, if speedy improvement does not ensue,[1] the child should be examined by an oculist; a lotion, ointment, or other treatment may then be prescribed, and the teacher can assist by seeing that it is used.

Conjunctivitis is rarer. But an inflammation of the delicate membranes that line the eyeballs and the eyelids may have more serious consequences. It is commonest in young and ill-fed children, who often suffer from sore nostrils, lips, and ears as well. It is frequently associated with catarrhal conditions of the nose and throat. Some forms clear up spontaneously as soon as proper glasses have been prescribed; others have a specific origin, and yield readily to medical treatment. Such cases are by no means rare among the healthier social classes; but, among children of the type with which we are dealing here, the trouble is apt to be more obstinate. With them better feeding, better cleanliness, and removal to a brighter and fresher neighbourhood, for preference by the sea, are, as a rule, likely

[1] In children from clean homes an obstinate type of chronic blepharitis often starts with an attack of measles. In spite of skilled dressings at the hospital or clinic, it will occasionally persist for years. Open-air treatment is frequently successful.

to be far more effective than any home-made medicaments applied to the local condition itself.

One factor, which often contributes directly or indirectly to these minor inflammations and which nevertheless is largely overlooked, is that of glare. Its influence is especially noticeable in open-air classes for weak or backward children. Here on fine days one may occasionally see small children put to rest on their backs with their eyes gazing up at a brilliant sky, and older children bending over their books with the sun brightly shining on the white page. Under such conditions, even healthy eyes are quickly irritated; and, if the child rubs them with his grimy hands, infection as well as inflammation may result. At the same time, in order to shut out the strong light, he keeps grimacing and puckering up his face; and, with those whose muscular co-ordination is at all irregular, the innervation is apt to overflow into the muscles that move the eyeballs, and the consequence is a temporary squint.[1] In arranging open-air classes for the backward, therefore, as much attention should be paid to the conditions of illumination as would be given by an official architect in planning the lighting arrangements for a new classroom in an up-to-date school.

(iii) *Strabismus* or squinting is attributable to a number of different causes. Those most commonly suggested are (1) hypermetropia, in which case the excessive efforts to focus near objects is supposed to foster a tendency to squint; (2) myopia, especially a greater weakness in one eye than in the other; (3) a defective neuro-muscular mechanism for simultaneously fixating the same object with the two eyes, and for simultaneously focusing the corresponding retinal images then obtained; (4) a more general weakness of neuro-muscular efficiency, either innate or due to diseases upsetting neuro-muscular control, such as diphtheria and the like. In the cases noted during the course of my own investigations, the causes were usually mixed—sensory defects and motor defects being both very frequently observable.

[1] The squinting may often be noticed in such children, when they try to fixate in bright illumination; and I am tempted to inquire whether, in the tiny infant left lying in the sunshine, a more permanent squint may not be produced by this cause.

The figures for the incidence of a discernible squint[1] are given in Tables XIII and XIV. As will be seen, it was found rather more frequently among the backward children than among the normal, and particularly among the boys as compared with the girls. The correlations, however, though positive, are hardly high enough to demonstrate, on the basis of the statistical evidence alone, an indisputable connexion between squinting and backwardness. A study of individual cases seemed to indicate that in several instances, especially among the boys, the tendency to squint had definitely hindered reading.

In about three-quarters of the cases errors of refraction were discovered—usually hypermetropia ; divergent eyes were found mainly in myopic children (often of low-grade intelligence), convergent eyes ('crossed eyes'—by far the commonest variety) mainly in the hypermetropic. But in some of the most marked and most obstinate squinters no refractive error of any sort could be detected. In these

[1] The less obvious cases of squinting often remain for some time unnoticed. They can best be detected by asking the children to look at the examiner's right eye ; the squinting eye is then seen to be turned towards some other point : if now a card be placed in front of the fixating eye, the squinting eye jerks round to look at the examiner. The mildest cases of all, and the cases of latent tendency to asymmetry (heterophoria), need, for decisive ascertainment, a special test in a darkened room. (For methods, see Whipple, *loc. cit.*, pp. 175 *et seq.*, Tests 15A and 15B.)

In the tables under the heading of 'Squint' I have included a few cases in which a marked heterophoria appeared to be interfering with the ease of the child's reading. This seems justifiable because, as I find from repeated examinations, a child who is markedly heterophoric one day may be found to be squinting on another. Here, however, are lines of inquiry in which the *degree* of the defect should be taken into account in future intensive researches. So long as the same examiner is dealing with all the cases, the results are sufficiently comparable ; but the records can hardly be comparable from one examiner to another unless the defect is more precisely measured: at the same time a measurement of its varying amount would enable a more accurate study of the correlations to be undertaken. My colleague, Dr. Philpott, has shown that there is a marked correlation between heterophoria and spatial perception, but that the regression is curvilinear: this suggests the need for further investigation into the bearing of heterophoria and kindred defects upon the child's recognition of printed letters.

The figures obtained by Dr. Lloyd at Birmingham appear very much higher than my own. But in his account of his methods he points out that he included a large number of slight or latent cases (*loc. cit.*, p. 43).

the trouble seemed to manifest itself rather as a local symptom of a general deficiency in nervous control: several, for example, showed tendencies towards stuttering, left-handedness, and clumsy control of the fingers and hands. This no doubt explains why squinting is so prevalent among the most seriously backward and the mentally defective.

Treatment.—'Children,' said the doctor to Mr. Pepys,[1] 'look several ways with both eyes, till custom teaches them otherwise'; and the power of binocular vision, with the two eyes looking parallel and working together in harmony, has to be ripened and fixed by exercise. If one eye is weaker than the other, the task is as difficult as learning to drive an ill-matched pair of horses harnessed to a single cart: in either case it is the control of the driver that tells. The obvious treatment, therefore, is, first of all, to correct any weakness in the squinting eye, either by a suitable lens or by giving it extra exercise while the straight eye is covered with a blinker; and, secondly, and at the same time, to tone up the child's general nervous control by all available measures. The straight eye, however, is usually the eye with the sharpest vision. Hence, whatever methods are adopted, the child is likely to be handicapped for all visual work in the classroom, and to find such work peculiarly aggravating. Squinting is often intermittent: it may be seen, for example, only when the child is tired or emotionally disturbed. Consequently, the detection of an occasional squint becomes a most important task for the teacher.

In cases that resist these gentler efforts it is often considered necessary to put the squinting eye straight by a surgical operation on the guiding muscles. Probably, however, few cases of squint would require an operation if only they were discovered and treated at an early stage. In the older and severer cases the operation often improves nothing except the child's personal appearance.[2]

[1] *Diary*, May 24th, 1660 (ed. Wheatley, I, p. 149).

[2] The teacher who wishes to study the whole subject further will find an excellent introduction in Dr. James Kerr's little book, *School Vision* (1925). He should also be familiar with the admirable report of the Board of Education Committee of Inquiry on *Partially Sighted Children* (H.M. Stationery Office, 3*s*.) which has been issued since the above was written.

B. Defective Hearing

Influence of Auditory Defects.—If it is mainly through the eye that we discover the qualities of the world of things, it is chiefly through the ear that we become acquainted with the world of human beings. Sight helps us to learn from our material environment; hearing, to learn from our social environment. During childhood the social environment has a twofold value. In listening to the persons about us, we are not only learning about human beings themselves; we are also learning what they have to tell us about the silent universe of things. Thus, by keeping in touch with our social surroundings, we get to know more and more about our material surroundings as well: the very existence of that long dependent phase of immaturity called childhood has for its main purpose the grand opportunity that it yields to the newcomer for getting to know from the older inhabitants all that he can about the world he has just entered. Now the quickest, the easiest, and the most intelligible mode of communication between one man and another, and above all between the old and the young, is speech. With children who are too young or too dull to learn by reading, speech is practically the only means by which human knowledge can be handed on. Those, therefore, who from the outset of their lives are deaf to human speech, are left in tragic isolation. No doubt, amid the noises of these modern days, many of us who are already grown up would choose rather to be deaf than blind: we can compensate through books. But for the tiny child, deafness is beyond question the more grievous calamity of the two.

This difference between their indirect effects, so obvious in the gravest forms of the two disabilities—in total blindness and in total deafness (or what passes for such)—is operative on a smaller scale in the slighter forms. Lesser defects of hearing seem much rarer than lesser defects of vision; nevertheless, as will presently be seen from a comparison of my figures, the former offer a far more serious bar to school progress than the latter—more serious indeed than almost any other physical infirmity. Among boys and girls who

gain scholarships, defective sight is by no means uncommon; but to find a pupil who is partly deaf and yet shows high ability in his work at school is altogether exceptional.

Not infrequently children are referred to the psychologist as cases of mental deficiency, when on examination they prove to be merely deaf: the child sits at the back of the class, dull, impassive, inattentive, and appears to make no headway whatever; after a term or two in the senior department, he is found to be so backward and obtuse that not his ears but his brains are thought to be at fault. In the infants' school and in the lower classes, where teaching is mainly oral, the deaf child's progress is likely to be penalized in every direction. At a later stage reading in particular is liable to suffer; the child's knowledge of the constituent sounds that make up syllables and words is too vague and inexact for him to relate them to their respective symbols. In spelling and dictation his mistakes may spring from nothing but inability to hear, and to analyse through hearing, whatever has been said. Even arithmetic may at times be affected. The deaf child can often do mechanical computations perfectly; but the teacher's exposition of new rules he cannot catch and therefore does not understand. Mental arithmetic more especially may reveal instructive blunders; but all oral work is liable to be disturbed.[1]

Tests of Auditory Acuity.—It is amazing to discover how, day after day, deaf children can conceal their defect from their teacher, and get put down as merely dense or stupid. Among the young as well as among the grown up, there are plenty who fail to hear almost everything they should hear, and yet succeed quite well when not expected or intended to hear. A single auditory test carried out during the medical inspection, often with a good deal of noise

[1] In one of my regular tests in mental arithmetic the child is asked how much he would have left out of 12*s.* if he spent 5*s.* 11½*d.* One boy replied quite promptly '2*s.* 4½*d.*' He had understood me to say 9*s.* 7½*d.* On my relating this to the teacher, I was shown a recent composition by the same child. The title suggested by the teacher, and actually written on the board, was 'How I spent my Christmas holidays.' The boy had described how he had spent his 'Christmas pocket-money.' Every teacher of experience, however, will have a store of similar blunders, more pathetic than amusing, committed by children who are slightly deaf.

going on, may easily miss more than half the slight and intermittent cases. The doctor is consequently obliged to depend in a large measure on the reports of those who are in daily contact with the child.

It is, then, essential that the teacher should be alert to note any sign of such disabilities. The tilt of the child's head as he turns his better ear, the intentness of his eye as he watches the teacher's lips, his trick of muttering over to himself questions or instructions that he has not quite caught, the way he cranes forward with his mouth half-open, either to reinforce his hearing, or, more frequently, because his nose as well as his ear-passages is partly blocked—these and other little mannerisms will often betray even a minor case in class. With others nothing but systematic and repeated testing may suffice to elicit the symptoms; and, indeed, a systematic survey of all school pupils, by up-to-date scientific means, soon after they enter school, is much to be desired. Here again the teacher should be acquainted with the simpler methods that can be used.[1]

To test auditory capacities is a far more difficult task than might at first be supposed. As ordinarily carried out in the schoolroom, the examination of the child's hearing is even more rough and ready than the examination of his vision. In consequence, no reliable statistics exist in regard to the prevalence of auditory defects either among school children or in the population at large.

Here, at the outset of our discussion of psychological testing, it may be well to formulate two general principles which, I believe, every psychologist would accept. Nearly all our testing has two main aims—preliminary detection and individual diagnosis; and we may lay it down as axiomatic, first, that that part of the testing which is

[1] 'It would be valuable,' says a medical colleague of wide experience, 'both for public health and for education if hearing tests had to be done by teachers. They are often unaware of deafness; and seem to take little interest in it' (J. Kerr, *Fundamentals of School Hygiene*, 1926, p. 580). London County Council's aural specialist also urges that tests of hearing should be 'carried out by teachers known to the children.' This is the practice in the United States. On the general subject of the examination and training of deaf children, see the admirable book by I. R. and A. W. G. Ewing, *Opportunity and the Deaf Child* (University of London Press, 1947).

designed to measure the net efficiency of a function for practical purposes should call into play the same concrete processes as are required by the ordinary activities of everyday life; secondly, that that part of the testing which is designed to discover the causes of any inefficiency thus revealed should, so far as possible, deal separately with the several elementary capacities, known or assumed to underlie the more concrete and complex processes. Throughout, therefore, we must bear in mind what I am tempted to call the extreme specificity of specific mental functions. All recent work on mental testing tends to show that the elementary capacities of the mind, sensory, motor, perceptual, associative, and the like, are highly limited in their influence: from a test of one particular activity it is always precarious to draw inferences about the efficiency of some other activity.

Let us apply these principles to the usual means of measuring the efficiency of hearing. For the practical purposes of education we need primarily to measure the child's power of understanding the teacher's voice in the classroom: the recognition of musical sounds and the discrimination of small differences of pitch will be of interest in considering the child's musical education, but may here be treated as of merely secondary importance. Where this preliminary examination reveals cases of relative failure, the extensive survey must be supplemented by an intensive etiological investigation of each individual so picked out, with a view to determining the probable causes and the appropriate treatment. For these diagnostic purposes, it will be necessary to investigate which ear is weaker, whether the source of the weakness lies in the external canal or the Eustachian tube, in the drum or the ossicles of the middle ear, in the receiving mechanisms of the inner ear, or in the central neural mechanisms concerned with the perception and interpretation of sounds, and finally whether the difficulty arises chiefly in connexion with certain intensities, certain levels of pitch, or certain patterns of sound. This second inquiry is the task of the specialist; but, to cooperate intelligently in the classroom treatment which the specialist will prescribe, the teacher must also know some-

thing of the principles on which that treatment is based. If, too, he is himself to assist in the preliminary detection, he must be familiar with the more general tests of lessened auditory efficiency. But whoever actually applies such tests, whether teacher, doctor, or psychologist, should first of all be trained in the requisite psychological technique.

(i) *Watch Test.*—The watch test,[1] which was for so long a favourite, serves neither of the purposes I have described. At times it may be used as a convenient and homely device for preliminary observations; but, as a scientific method, it may be rejected forthwith. In an enclosed space the ticks often provoke illusions of hearing, and differ greatly from one watch to another. But, above all, such a test has little relation to the capacity to perceive human speech.

(ii) *Speech Tests: (a) Vocalized.*—For testing practical efficiency the natural method is one in which the ordinary voice is used and in which acuity is measured by the maximum distance at which the voice can be heard. Simple commands, whose content can be readily understood and obeyed by the child, will provide the most appropriate test material: the mere repetition of isolated numbers involves a slightly different task; and moreover many isolated numbers can be guessed from the vowel sounds alone.[2]

For children suffering from serious deafness, this provides by far the best test. Yet with those whose hearing is but little impaired, such a procedure is difficult to apply in the ordinary school owing to limitations of space and unavoid-

[1] A standard procedure is described by Whipple, *loc. cit.*, 2nd ed., I, pp. 207 *et seq.*, Test 18B.

[2] Different sounds are audible at very different distances. Vowels, for example, carry much farther than most consonants. Sibilants and close front vowels (*e.g.* ee) can be distinguished at a much greater distance than unvoiced plosives (*e.g.* t) and back vowels (*e.g.* u in 'cut'). 'Sixty-six' can be recognized at about twice the distance of 'twenty-one'; and numbers with similar vowels, like 'nine' and 'five,' 'seven' and 'eleven,' are continually confused. Recognizability is not quite the same as 'phonetic power' or relative loudness. The open vowels (*aw* and certain pronunciations of *ah*) have the most powerful sound, and the unvoiced fricatives (*f* and *th*) the faintest. Measured in microwatts the intensity of the former is nearly 700 times that of the latter; measured in sensory units or decibels, the difference (owing to the operation of the Weber-Fechner law) is not so great. (Cf. Fig. 6, p. 246.)

able differences in the competing background of noise. In a quiet, well-built hall, the ordinary voice can be heard by a person with normal hearing at about 120 feet; and in an average school hall at about 60 feet, with wide variations depending on the conditions of the moment and the structure of the particular building. But many schools and clinics have no hall of this size; and, when they have, it is rarely available for prolonged and systematic tests of hearing.

(ii) *Speech Tests: (b) Whispered.*—For the preliminary testing of milder defects of school children, therefore, whispered speech has generally been employed both in this country and elsewhere during recent years.[1] The whisper should be a standard whisper: one of our best authorities has remarked that the 'whispers' of some examiners are more like the 'death-rattle of a despairing and infuriated elephant—a bellow for which the normal limit is a thousand yards, not the Board of Education's limit of twenty feet.'[2] Hence, to keep the utterance of uniform quality and intensity, the sounds should be made at the end of an expiration: as one textbook quaintly puts it, the whisperer first 'expires,' *i.e.* empties his lungs as completely as possible, and then speaks with the residuary air. If this method is adopted, it will be found that whispered speech varies far less from one examiner to another than the ordinary voice, and is far less influenced by the acoustic properties of the room in which the examination is carried out.

To begin with, a rough group-test may be attempted by placing the children in a row at the back of the room, and then giving whispered numbers to be written down, or, better still, whispered instructions to be performed. For more exact purposes, each individual, and even each ear, should be tested separately. To prevent lip-reading, the child should either close his eyes, or turn his back or the

[1] See Board of Education's *Instructions to School Medical Officers*, 1912. Under good conditions, in a quiet place, free from reflections or air currents, the ordinary voice can be heard by a normal person at about 1,000 feet; and a forced whisper at about 100 feet. In a quiet schoolroom a forced whisper can be heard at about 40 feet.

[2] Macleod Yearsley, *School Hygiene*, VI (1915), 'Hearing Tests in School Children,' p. 154.

side of his face towards the speaker. The acuity of any given individual may be assessed in one of three ways: first, by the percentage of numbers which he can correctly repeat at a normal range (the normal range itself being first experimentally ascertained by the same examiner in the same room); or, better, by the ratio [1] of the farthest range of the child tested to the average range of normal children; or, finally and most simply, with any convenient constant range, by the ratio of the number of whispers heard by the child tested to the average number heard by a normal child at the same distance.

It should be noted that, in an ordinary room, audibility does not vary with the distance only: reflection and resonance will at times unexpectedly enhance or confuse the sounds. Hence it is safer to average the results obtained by the method of 'constant range' and 'extreme range' respectively. The tests should be repeated on subsequent days, since hearing and partial deafness are with some extremely variable. As a rule, a child with good hearing will be able to hear whispered speech quite clearly across the whole length of an ordinary classroom; and for rough purposes his hearing may be considered normal if he can hear it at a distance of 20 feet.[2]

In the preliminary examination of the groups of normal and backward children here described, Dr. Lloyd and I relied mainly upon the whisper test, carried out as above described. The hearing capacity of each child was measured in terms of extreme range, corrected, so far as possible, for peculiarities of the different schoolrooms and of the general conditions of the examination, by the aid of the supplementary tests to be described in a moment. To

[1] See footnote 1, p. 236.

[2] This is the distance laid down in the *Annual Report of the Chief Medical Officer of the Board of Education* (1912, p. 47). For criticisms, see Yearsley, *loc. cit.*, pp. 146 *et seq.* Since the reflection of sound from walls, ceiling, solid furniture, and floor, and, above all, noises from outside, greatly affect the range of audibility indoors, the room should be central and as large as possible (*e.g.* the school hall), and the surroundings should be kept as silent or at any rate as constant as possible. For more detailed instructions in regard to method and technique, with a selected list of test-numbers, see Whipple, *loc. cit.*, pp. 204 *et seq.*, Test 18B.

render our figures in some degree comparable with those of existing reports and surveys, we have endeavoured to follow the classification adopted hitherto by most school medical officers.

Teachers tend to classify children into two groups only —the perfect hearers and the stone-deaf: they are surprised to find that there are all degrees of auditory weakness, from an acuity well above normal down to total silence. Even the official classifications fail to do justice to the various grades to be found among the milder and more frequent cases. Children who have less than three-quarters [1] of the normal hearing—*i.e.* cases where the child, using both ears, cannot hear a forced whisper beyond 15 feet—will here be recorded as 'slight' cases; children who have less than half [1] the normal hearing—*i.e.* cases where the child cannot hear the whispers even with his best ear at 10 feet—will be described as cases of 'marked' defect. Children who cannot hear a forced whisper 5 or 6 feet away with at least one ear will be termed 'hard of hearing'; those who cannot hear a whisper at 3 feet may be considered 'partially deaf.' These loose descriptive phrases, however, though used in official publications and instructions, should in my view be dropped. They suggest the existence of distinct groups instead of varying grades, and are, as a rule, exceedingly ill-defined. For administrative purposes it would probably be sufficient to recognize three broad classes: those with 'slight,' those with 'marked' though moderate, and those with 'severe' degrees of auditory defect, and, for the rest, to define these three classes, and

[1] These fractions, like the ratio suggested above (p. 235), must not be taken too literally. Strictly speaking, a measurement in terms of a simple ratio is invalid; and I have used it only to give a rough notion of the practical consequences of the defect. Theoretically the intensity of the sound varies inversely with the square of the distance; but the conditions of school testing render this, and any other theoretical rule, of little value in actual practice. Because of the irregular effects of increasing the distance, it is usually wise, before beginning the test in any fresh room, to compare the results obtained by varying the distance with the results obtained by keeping the distance constant and varying the strength of the sound. I may add that the child's ears should be inspected first of all: temporary accumulations of wax may render the results decidedly variable from time to time.

to specify the defect of the individual, in terms of actual loss of hearing as revealed by standardized testing.

(iii) *Acoumeters.*—In the psychological laboratory, the various capacities of hearing are tested in greater detail by means of specially devised apparatus. Simple acuity—the lowest intensity of sound which can just be heard—is commonly measured by an instrument known as an acoumeter. Politzer's acoumeter is the form best known and most extensively used in clinical work abroad. In this a small hammer, dropped upon a steel cylinder, yields a brief tone of constant intensity and pitch (an octave above middle C) the examinee's acuity is measured in terms of extreme range. Lehmann's acoumeter is preferable where space is limited. In this a steel ball is dropped upon a glass plate, and by diminishing the height of the drop the intensity of the sound can be diminished indefinitely. The examinee sits at a constant distance from the instrument, and his acuity is measured by the faintest noise that he can hear—*i.e.* by the shortest distance through which a ball of specified weight is dropped.[1] The use of both instruments with the same children is instructive, since it demonstrates that hearing for complex sounds or noises does not run parallel with hearing for simple musical tones: with a group of 45 deaf children I find the correlation to be only ·54, and with a group of 63 normal children only ·36.

(iv) *Tests of Pitch.*—The laboratory tests of hearing,

[1] Besides the distance of the drop and the weight of the ball, there is a third factor—the sonority of the glass plate. It seems to have been tacitly assumed that, unlike the natural voice, the artificial acoumeter does not vary in sonority from one individual instrument to another. Actually it will be found that results are not comparable unless obtained with an identical instrument.

Lehmann's acoumeter was the instrument originally recommended in Whipple's tests for auditory acuity (*loc. cit.*, 1910 ed., I, p. 173, Test 18B), and a full description of the standard procedure was appended; in the second edition this has been omitted and a short description of the watch test substituted. Accordingly, it may again be well to remind those untrained in psychological technique that, in all determinations of sensory thresholds, some systematic procedure or 'psycho-physical method' must be followed, if the results are to be reliable and comparable: the standard methods are described in all textbooks of experimental psychology (*e.g.* Myers' *Textbook of Experimental Psychology*, 1911, pp. 233 *et seq.*).

however, deal, not only with the loudness or intensity of sounds, but also with their quality or pitch. In the more detailed examination of a child whose hearing is defective the most important point will therefore be to measure, not merely his general sensitivity to sound as such, but his sensitivity to sounds of different pitch. To the teacher, tests for range and discrimination of pitch will be of interest, not merely because they may throw some light on the child who is backward in music and singing,[1] but—what is far

[1] For investigating the musical capacities of children several systems of testing have been attempted. Of these the best known is that of Seashore (*The Psychology of Musical Talent* (1919)). A more recent set of tests, in many ways better adapted for work with children, are those devised by Kwalwasser (*Tests and Measurements in Music*, Birchard & Co., Boston, 1927: cf. also *The Kwalwasser Test of Musical Information and Appreciation*, Bureau of Musical Information and Appreciation, University of Iowa, 1927). In these tests, pitch-discrimination and similar abilities are estimated by means of musical tones recorded on gramophone discs: tests of more complex capacities are included, such as the appreciation of consonances and cadences. The simpler of these tests may be used for investigating the child's hearing of pitch, though, in my own experience, they are not so satisfactory as the methods described in the text.

The musical abilities of backward children are the subject of frequent comment among school teachers, who often declare that dull or defective individuals are quite equal to the normal in musical appreciation, and suggest that more might be made of such talents in the classroom. My own experience is that, as in handwork, so in music, the capacities of the dull and defective appear unusually high only in comparison with their own low performances in more academic subjects: rarely are they as good as those of a normal child of the same age. I agree, however, that special talent in this direction is too often overlooked, and might be more systematically watched for and tested. The American tests I have found disappointing. With the assistance of one or two research students I have endeavoured to compile tests of musical capacity which shall require, not a costly set of gramophone records, but merely the ordinary school piano. For those teachers who are attempting similar investigations for themselves, two points are perhaps worth stressing. First, in music, as in pictorial art, the psychologists' standards (as shown by their published tests) are often far removed from those that would be accepted by the best modern critics: in the American tests just mentioned, for example, the 'correct' preferences in consonance rest frequently on theories of harmony that are now entirely out of date. Secondly, I find that the method of correlating the relative performances of individuals with an ideal (a method that I have described and used for pictorial appreciation) yields by far the best method of measurement. With music, however, there are special difficulties: a child can arrange

more important—because of the part played by pitch-differences in the understanding of language and in the analysis of word-sounds during the early stages of reading.

Ordinarily it is tacitly assumed that an ear that is partly deaf will be equally deaf to all kinds of sounds or noises, no matter what their special quality or nature. That is rather like supposing that the loud-speaker of a wireless set will reproduce with equal clearness, or with equal obscurity, every kind of note. But, just as most colour-blind persons are blind only to certain colours in the spectrum, so other persons are deaf, or relatively deaf, only to certain portions of the tonal scale. This gives rise to peculiar differences in the form of deafness, which until recently have been almost wholly overlooked; and a thorough analysis of defective hearing corresponds in many ways to the analysis of defective colour-vision. But in practice the methods of analysis are by no means so simple to apply as the tests for colour-vision.

In the first place, as with colours, so with tones, it is desirable to work with stimuli that are as pure as possible. The teacher will think first of trying a test with the piano, since a piano is available in every school. Such an instrument, however, is unsatisfactory. To begin with, its notes are never pure; they are accompanied by overtones and by a certain amount of noise, and these may easily be heard by a child who is deaf to the fundamental tone. In listening to the higher notes at a distance—the most important form of the test—the objection is not so serious. But here the piano is inadequate on other grounds; its notes do not go high enough to enable the commoner cases to be detected. The psychological laboratory seldom contains a piano, but nearly always possesses a monochord. A monochord can easily be manufactured by stretching a banjo wire over a resonating box, and stopping it down with a movable

twenty pictures in order of preference as he looks at them; he cannot arrange twenty tunes in order of preference as he listens to them. If he knows them already, he can do so when he is merely given the names: but when the tunes or phrases are fresh to him, special technical devices have to be employed to obtain a fair ranking, and the method of paired comparison proves in general to be the most practicable procedure.

bridge. Sounds of a very high pitch can be obtained; and for rough tests this simple apparatus proves of considerable value.

But in general the laboratory psychologist has shown a preference for the tuning fork, as yielding a purer sound than any other instrument. A pair of tuning forks are commonly used for measuring small differences in pitch; and a calibrated series, ranging by octaves from C_2 (32 vib. per sec.) to c^4 (2,048 vib. per sec.) or higher, is often employed for determining limitations in range.[1] To regulate and equate the loudness of the different notes, however, is far from easy; nor do the sets as usually constructed run high enough to determine the upper limits in the milder cases. To obtain tones well beyond the ordinary musical

[1] The testing of simple auditory acuity and of pitch discrimination by means of tuning forks is described by Whipple, *loc. cit.*, pp. 208 *et seq.*, Test 18C and Test 19; but no method is there given for determining the degree of what might be called pitch deafness.

The tuning fork is also systematically used in endeavouring to locate the source of the deafness. Two criteria in particular are employed.

(1) *Rinne's Test.*—The vibrating fork is first placed upon the mastoid bone behind the ear, and the patient is asked to indicate when he ceases to hear it. It is then rapidly brought close to the external canal. If hearing is normal, the sound can be heard for about twice as long by air conduction as by bone conduction. If some defect of the auditory conducting mechanism is present, hearing by air conduction may be very much diminished: if the canal itself is blocked, or the drum or bones of the middle ear are damaged, no sound at all may be heard when the fork is moved to the opening of the ear. If, on the other hand, the defect lies in the sensory cells of the inner ear or their nervous connexions, the hearing of bone-conducted sounds will be equally reduced below the normal (cf. the results recorded in Fig. 8).

(2) *Weber's Test.*—To discover differences between the hearing capacity of the two ears, the stem of the tuning fork may be placed either on the top of the head or between the front teeth. If both ears hear equally well, the patient will probably perceive only a single tone which he locates in the middle of the head, or he may declare that he hears a sound in either ear of equal loudness. If, however, one ear is more defective than the other, then this ear may hear the tone either more faintly or (paradoxically enough) more loudly than the other. In the former case, *i.e.* when the sound is heard better by the better ear, the defect on the other side probably lies in the inner ear or in the more central portions of the auditory mechanism. In the latter case, *i.e.* when the sound is heard more loudly by the ear which previous tests have shown to be the more defective, the defect lies most probably in the external or the middle ear, and is more likely to yield to appropriate medical treatment.

scale, Galton invented a minute whistle which will emit notes from 4,096 to about 25,000 vib. per sec.; and until recently this has been regularly used by psychologists to determine the upper limit of hearing in normal persons.

In the use of these various instruments—acoumeters, standard forks, whistles, monochords, and the like—all students of experimental psychology are now systematically trained. To the aural specialist, such contrivances may at times be exceedingly helpful in diagnosing probable causes; but in working with children the use of apparatus tends to set up a highly artificial attitude, unless the examiner is already familiar with the special difficulties that are encountered. For the purposes of preliminary detection in the classroom, particularly with the young and with the dull, instrumental tests of this type are generally worse than useless. The complexity of the procedure transforms what should be a pure test of sense-perception into a partial test of intelligence; and the results obtained have a demonstrably low correlation with the capacity of the examinees for recognizing speech. I venture to suggest that, in these respects, the practical exercises of the psychological laboratory now need to be brought much more closely into line with the latest work on the testing of hearing.

(v) *Audiometers.*—To rule out the influence of intruding noises and of conduction across a space of varying distance and character, attempts have more recently been made to devise an apparatus which will permit testing at the ear itself. Most of these instruments are constructed on the principle of a telephone receiver; tones, noises, or words are produced by a gramophone disc or other means; and the loudness of the sound can be graded and measured with the aid of a rheostat. Nowadays nearly every child is familiar with earphones, gramophones, and telephones; hence the use of such appliances no longer seems to them artificial or formidable, and with a skilled investigator may actually arouse an enhanced degree of interest and attention.

(*a*) *Gramophone Audiometers.*—For preliminary surveys, the most useful apparatus now available is undoubtedly the

gramophone audiometer with verbal test material.[1] In competent hands it not only discovers defects that might otherwise be missed—*e.g.* defects affecting one ear only, but also provides a fairly accurate estimation of the degree of the defect. Since a large number of headphones can be provided, it is possible to test the older or more intelligent children in groups—a whole class at a time. In its usual form the method requires the children to write down figures from dictation. This might easily lead to an over-estimation of the number of defects among the backward, the dull, and the very young. With these it would be better to use, not numbers, but names of concrete objects, and allow the child to pick out corresponding pictures.

(*b*) *Pure Tone Audiometers.*—Scientific research upon wireless telephony has now rendered it possible to construct apparatus in which pure tones can be generated electrically and delivered to a receiver held at the ear of the patient: the pitch can be easily altered, the volume easily regulated, and both accurately measured. By the systematic use of

[1] The *Annual Report of the Chief Medical Officer of the Board of Education* for 1931 describes the method in detail. Up to the present, the returns available from different areas seem to yield figures that are highly discrepant, and evidently the technique and the conditions of the testing vary considerably in different hands. Quite recently the London County Council has commenced a survey of the schools within its area, to be carried out with this apparatus by two trained specialists. The figures obtained by the older methods and published from time to time in the annual reports of the Board or of local education authorities reveal such wide irregularities that one is forced to conclude that they are determined not so much by the aural conditions of the children as by the acoustic conditions of the school and probably also by the peculiar technique of the examiner. Accordingly, in view of the extreme uncertainty of existing statistics, it is much to be desired that surveys by the newer method should be undertaken, not only among school children, but also among adults from different districts, different social classes, and, in particular, different trades and occupations.

I may add that I have lately had an opportunity of analysing figures supplied to the British Broadcasting Corporation by schools that have taken their tests for the efficiency of reproduction in the wireless sets in different classrooms. It is interesting to find that several unsuspected cases of deafness have incidentally been brought to light in this way. Such experiments, if they do not solve, at any rate serve to throw into high relief, the problems of individual hearing in the classroom. The available data, however, show very clearly how an understanding of psychological principles is necessary before any tests of this nature can be successfully attempted.

such an appliance, it is possible to plot out, for any given person, the threshold of audibility for sounds of different level. The results are most conveniently expressed in the form of a curve of hearing—an audiogram, as it may be called, in which the base-line represents the pitch of the sound in octaves, and the vertical lines represent in decibels the intensity of the sound that is just audible at each pitch (see Fig. 8, p. 250).

Results.—To interpret the results obtained by these test-methods, to describe in detail the defects thus revealed, and to discuss their probable causes, would require a long and technical discussion, quite out of place in a volume such as this. For fuller information on the problems of diagnosis the reader must, therefore, be referred to the standard textbooks.[1] The main practical points will be these: (1) to determine the general degree of hearing loss, so that children who are more seriously handicapped may receive special expert attention, and those who suffer from milder defects may be appropriately dealt with in the ordinary classroom; (2) to decide whether the underlying condition is likely to be improvable by medical or surgical means, so that, if necessary, the child may receive proper treatment at the earliest possible moment; (3) to determine what modifications of the ordinary teaching methods are necessitated by the peculiarities of each individual case; and, in particular, (4) to discover whether the regions of pitch chiefly affected are those of special importance in the hearing of speech.

Incidence of Auditory Defects among the Normal and the Backward.—Since both at London and at Birmingham the groups investigated were comparatively small, and special schools for the deaf were outside my purview, my figures give only the roughest notion of the prevalence of auditory defects among the total school population. More exact information on this point is urgently required.

[1] A simple account is to be found in J. Kerr Love's book on *The Deaf Child* (Bristol, 1911). I may also refer to the series of papers recently published by Macleod Yearsley, formerly Consulting Aural Surgeon to the London County Council, 'An Analysis of 4,000 Cases of Educational Deafness,' *British Journal of Children's Diseases*, XXXI, 1934, pp. 177 *et seq.*; XXXII, 1935, pp. 21 *et seq.*

In groups possessing normal educational attainments, the proportion showing ' marked ' defects of hearing was barely 1 per cent. ; the proportion showing ' slight ' defects was 4 per cent. in London and nearly 15 per cent. in Birmingham.[1] Among the backward the number showing marked defects of hearing was about 6 per cent. in both London and Birmingham, nearly half being children who would be classified (by those who use the phrase) as definitely ' hard of hearing '[2] ; the number showing slight defects amounted to 12 per cent. in London and over 18 per cent. in Birmingham. We found no instances in either area, within the schools examined, of ' partial deafness,' as usually defined.[2] (See Tables XIII and XIV.)

The coefficients of correlation show clearly that defective hearing is associated with educational backwardness far more closely than defective sight.[3] In both investigations the correlation between backwardness and ' marked ' defects of hearing proves to be the highest in the table. In London the correlation for ' slight ' defects of hearing is nearly as high as for ' marked ' defects ; at Birmingham it is by comparison almost insignificant. At Birmingham, however, we found that the teachers were already alive to the special

[1] How far this difference between the two investigations was due to an accidental difference in standard, and how far it was the result of a genuine difference either in the social character of the groups examined or in the policy of the education departments and the teachers, it would be difficult to say. On the whole, it is improbable that the standards differed greatly. The striking fact seems to be that, at any rate at the time of our inquiries, children with slight defects of hearing were, at the Birmingham schools, more likely to make normal progress in their educational work. We were told that this was attributable to the special attention that had recently been drawn to the whole problem. Judged by the figures obtained among the control group, our criteria might appear to be less stringent than those usually adopted : but it must be remembered that this group was limited to children whose school attainments were normal. An estimate commonly given by aural specialists is that about 15 to 25 per cent. of the school population suffer from defective hearing of various degrees (cf. Whipple, *loc. cit.*, p. 209 ; Kerr, *loc. cit.*, p. 585) ; the audiometer survey at present being carried out in London schools will no doubt yield more precise and more reliable results.

[2] For definitions see above, p. 236.

[3] Seashore is almost the only investigator who finds ' no indication that the hearing of dull children is poorer than that of bright ' (*University of Iowa Studies*, II, 1899, pp. 158 *et seq.*).

needs of these children. In one case after another, the information was volunteered that the child had been exceedingly backward until a year or two ago, 'until' (as one of them put it) 'we found out he was hard of hearing and took him in hand.' The educational consequences, therefore, of these lesser defects are sometimes slight and sometimes serious—probably slight, if due allowance is made, certainly serious, if the trouble is overlooked.

Among children of ordinary ability hearing is one of the few sensory functions in which no clear sex-difference has hitherto been established. According to my own figures, there would seem to be an appreciable though statistically insignificant preponderance of auditory defects among the normal boys: among the backward, however, the boys seem more frequently handicapped by marked defects, and the girls by slight. The speculative may be tempted to connect this with the greater part played by speech in the upbringing of the ordinary girl.

Of the severer cases nearly all came from poor, dirty, and overcrowded homes. In the majority the trouble was the consequence of some infectious disease like measles or scarlet fever, of suppuration in the middle ear following some other cause (tubercular trouble, for example, or bad teeth), of adenoid growths, of blockage by accumulated wax, and finally—and perhaps commonest of all—of catarrh. Otorrhœa was noted in a number of the cases; but of itself appeared to have no demonstrable correlation with backwardness (see Tables XIII and XIV). No cases of congenital or hereditary deafness were found in these groups.

Influence of Auditory Defects upon the Hearing of Speech.—From an educational standpoint auditory defects are of special importance, not merely because they may at times prevent the child from hearing what is said, but also because they may distort or obscure it even when audible. Speech may be described as combining sounds of two levels of pitch which are heard simultaneously. There is, first of all, the deeper fundamental tone which rises and falls when we sing, or when we use semi-melodic inflections to indicate a question, a command, an affirmation, or some more specific emotion, and which serves, as it were, to carry speech.

Secondly, there are what may be regarded as higher overtones accompanying this fundamental note, serving to render speech articulate and intelligible. These overtones alter the

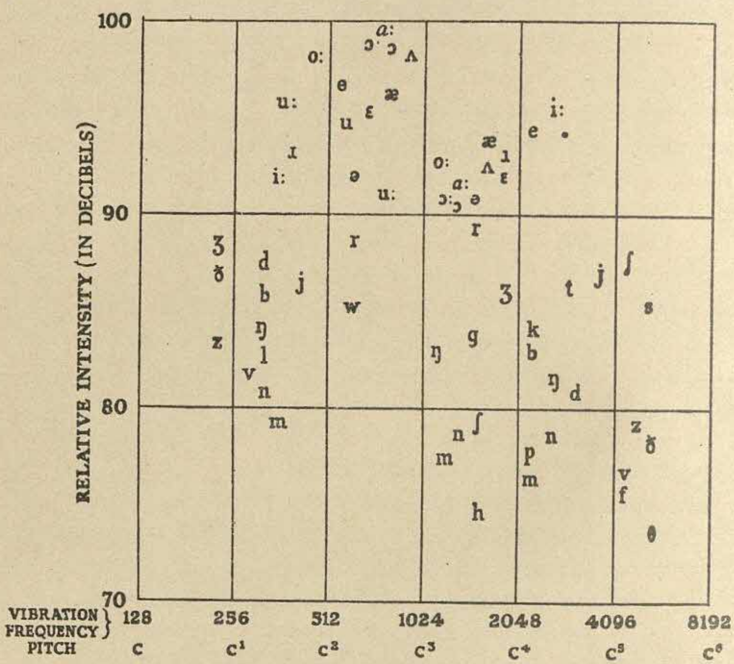


FIG. 6.—PITCH AND INTENSITY OF THE CHIEF COMPONENT SOUNDS IN ENGLISH SPEECH.

The symbols used are those of the International Phonetic Association. The vowels have approximately the Italian pronunciation: ɑ: as in *father*, ɔ: as in *all*, ɔ as in *not*, i: as in *see*, e as in *play* (diphthongalized in southern English), u: as in *rude*, ʊ as in *put*, ʌ as in *but*, æ as in *bat*. The consonants have for the most part their usual values. ʃ = *sh* as in *show*, ʒ = vocalized *sh* as in *pleasure*, θ = *th* as in *thin*, ð = *th* as in *then*, ŋ = *ng* as in *sing*, j as in *yes*.

timbre or specific quality of each sound as it is uttered. Much as the addition of certain harmonics differentiates the note of a clarinet from that of a cornet or a violin, so the addition of certain higher notes differentiates the vowels and consonants from one another. If, for example, you sing a z-sound (as in the word 'buzz'), you may easily distinguish the deeper note produced by the vocal cords (a

note in the neighbourhood of 128 vibrations per second, if you are a bass singer, and of 439 or thereabouts, if you are a soprano) from the high-pitched hissing (a note or noise in the neighbourhood of 7,500 vib. per sec.) produced at the same time between the tongue and the upper teeth. If you whisper the vowels in order—*oo*, *ah*, *ay*, *ee*—you may distinguish, as it were, a scale of faintly whistled notes, rising in pitch as the resonating cavities of the mouth and pharynx alter their shape.

The influence of these higher components can be best understood from the chart on p. 246 (Fig. 6). The diagram

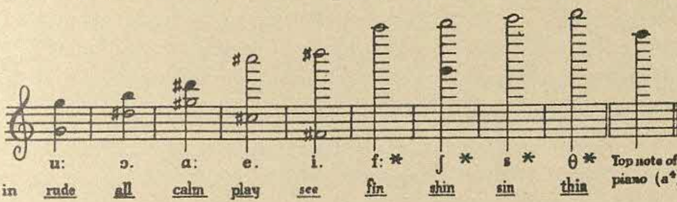


Fig. 7.—The Regions of the Characteristic Resonances of Certain Speech Sounds indicated in Staff Notation.

Note.—The fainter components are indicated by crotchets. The sounds marked with an asterisk (*) were inaudible in ordinary conversation to the boy suffering from high-note deafness whose audiogram is given on p. 250 (Fig. 8).

roughly indicates, for each of the vowels and consonants in the English language, the pitch and the loudness of the principal components. Fig. 7 shows the approximate pitch of the chief components in ordinary staff notation: here, however, it is impossible to indicate their relative intensity.[1] It will be seen that for the under-

[1] I am indebted to Dr. Harvey Fletcher, the Acoustical Research Director of the Bell Telephone Laboratories, New York, and to his publishers, Messrs. Macmillan & Co., for their kind permission to make use of the chart given in his book (*Speech and Hearing*, 1929, p. 76). My own diagram is based partly on Dr. Fletcher's diagram and figures, partly on the investigations of other workers, checked by rough observations of my own. Since in Harvey Fletcher's experiments the vowels were presumably given their American pronunciation, it is much to be desired that the work should be repeated in this country, and with standard sounds (*e.g.* the cardinal vowels and carefully defined representatives of the various consonantal phonemes). For an earlier attempt to analyse English sounds by ear (vowels only) and

standing of articulate speech the most important range lies between 250 and 2,500 vib. per sec.—say roughly between c^1 and f^4, that is, the notes of the treble stave and a couple of octaves above. But for the full appreciation of many common speech-sounds the hearing of still higher tones is of vital importance.[1] The shrill vowel *ee*, for example, is characterized by squeaky notes in the neighbourhood of 2,600 vib. per sec. such as are almost wholly absent from hollower vowels like *oo*. The sounds *s*, *z*, *f*, *v*, *sh*, *zh*, *ch*, *th* (voiced and unvoiced), are all characterized by fricative noises whose pitch is nearly an octave above the highest note on the piano ; and in the case of *s* and unvoiced *th*, it will be seen, these high-pitched sounds are not merely exceedingly faint, but are practically the only audible notes.

A child, therefore, who was completely deaf to these higher notes would still be able to follow the low undulating melody of the human voice during ordinary conversation, but would wholly fail to distinguish between the constituent

for references to previous investigations, see Sir Richard Paget's article on 'Voice Sounds,' *Encyclopædia Britannica*, 14th ed., *s.v.*, with bibliography, and his more recent volume, *Human Speech* (Kegan Paul, 1930, esp. pp. 40, 99, 310 *et seq.*).

[1] For the benefit of those who are more familiar with the musical nomenclature for pitch of tones than with the physical, it may be explained that the lowest note of an ordinary piano (A_2) is about 27 vib. per sec. and the highest (a^4) about 3,512 vib. per sec. (with English philharmonic tuning). For scientific purposes middle C (c^1) is taken to be a note of 256 vib. per sec. The bottom note of the bass clef, G, is a note of 102 vib. per sec., and the top note of the treble clef, f^2, is a note of about 683 vib. per sec. : the untrained bass voice can sing a note lying a tone or two below the former ; the untrained soprano, a tone or two above the latter. The fundamental tones of the conversational voice for male and female speakers lie well between these limits.

The bel is a logarithmic unit employed in telephone engineering to express the difference in intensity between two sounds. If these are denoted by S_0 and S_1, then the difference in decibels (d, say) is given by the formula $d = 10 \times \log_{10} \frac{S_1}{S_0}$. The addition of one decibel thus represents an increase in energy of approximately 26 per cent. over the preceding stimulus. At about 5 feet, ordinary conversation is roughly 50 decibels above the normal threshold of audibility ; a forced whisper about 15 decibels ; and a loud shout 2 inches from the ear about 70 decibels.

sounds themselves. Most vowels would appear very much alike to him ; and the unvoiced fricatives he would be quite unable to hear. Some notion of what human speech must sound like in such a case can be obtained by listening to an ill-adjusted loudspeaker that intensifies the bass and cuts out the upper treble. During infancy, a defect of this type may entirely prevent the child from learning to speak. As a result he will probably be set down as deaf-mute ; and in a sense he is. But with more careful testing it will be found that he not only hears sounds of a moderately low pitch quite well, but also seems to recognize the emotional indications of the voice, though he cannot discriminate articulate words as such : in fact, he responds to human speech rather like an intelligent dog. Accordingly, unless the peculiar nature of his defect is understood, he may easily be mistaken for a case of total deafness or, more commonly perhaps, of congenital aphasia.

High-note Deafness.—In the psychological laboratory it has long been known that wide differences exist in regard to the highest note which different persons can hear. Tested, for example, by the Galton whistle, it appears that an average ear can perceive notes up to about 20,000 to 25,000 vib. per sec. (about three octaves above the top note of the piano) ; many, however, cannot hear any note over 10,000 vib. per sec. unless the stimulus is exceedingly powerful ; and, with increasing age, the upper limit may gradually drop as much as an octave. Few people over 50 can hear the squeak of a bat.[1] More elaborate investigations have shown that, in this respect, almost every degree of limitation is to be found.

When systematically tested, the majority of persons suffering from defects of hearing prove to be limited, not merely in the loudness of the sound, but also in the range of pitch, to which their ears are fully sensitive. Children and adults

[1] Senile deafness almost invariably begins as high-note deafness ; but, once the recognition of speech has been learnt, the perception of high components is of minor importance : witness the readiness with which teachers accept loudspeakers in the classroom which are quite incapable of reproducing the higher components—a point strikingly exhibited in the B.B.C. investigation referred to above.

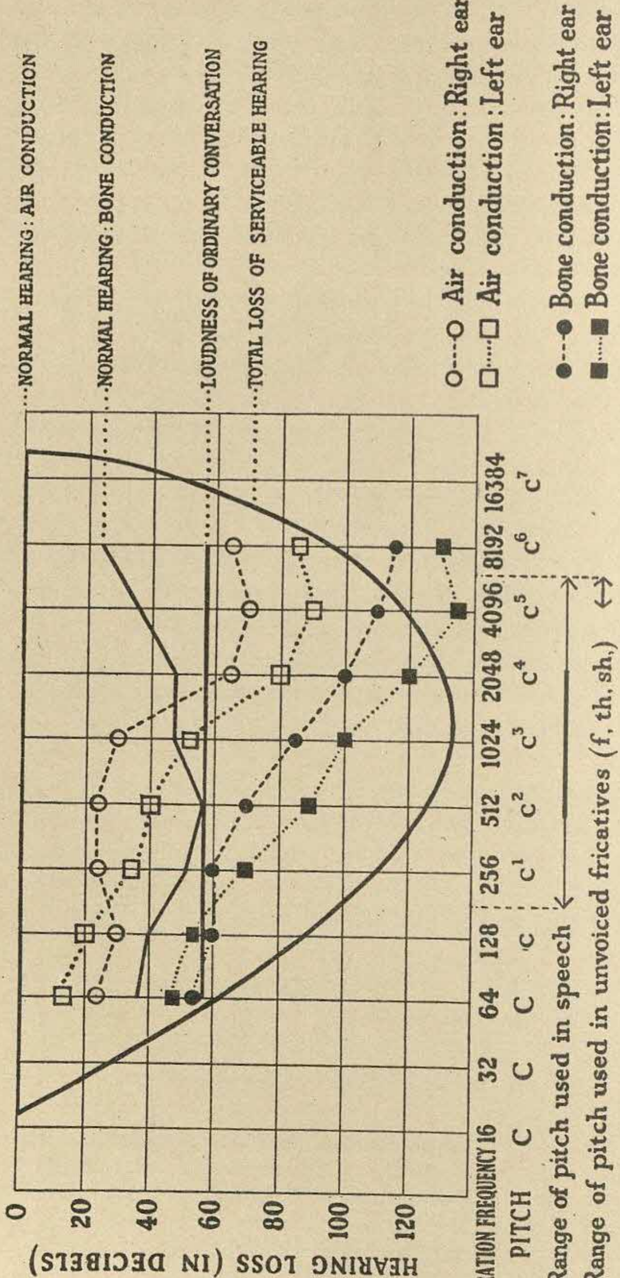


FIG. 8.—AUDIOGRAM OF BACKWARD CHILD WITH SO-CALLED HIGH-NOTE DEAFNESS.
Chronological age $12\frac{6}{12}$; mental age 11·5; educational age 9·8.

who are equally deaf to every note in the tonal scale are quite exceptional. The graphs or audiograms just described show clearly that, even for persons of normal hearing, very low and very high tones are far less easily heard and discriminated than tones falling within the middle range—the range involved in human speech (say 100 to 7,000 vib. per sec.). But the way in which audibility varies with variations of pitch differs considerably from one individual to another.

Among persons suffering from severe deafness (severe enough in the case of children to justify transference to a special school) it appears that about 65 per cent. have a maximal loss of hearing for the higher tones (above 2,000 vib. per sec.), and about 30 per cent. a maximal loss for the middle tones (500 to 2,000 vib. per sec.), the remainder having virtually a uniform loss throughout the tonal scale. Deafness with a maximal loss for the lower tones (below 500 vib. per sec.) is comparatively rare, and is usually characterized by what are loosely described as 'tone-gaps.'[1]

In the ordinary elementary school, well-marked cases of high-note deafness are seldom encountered; but in schools for the deaf almost every grade may be found. Within the backward group in London, I noted one child with a definite defect of this kind. His speech, I was informed, had been late in developing. Although his intelligence was nearly normal (M.R. 92), he did not talk till the age of 4. He had experienced an unusual difficulty

[1] In the severest cases of all, the condition may be best described by saying that the person is left with 'islands of hearing.' But the various types differ only in degree; and the brief phrase 'high-note deafness' must not be taken to imply that there is of necessity any extreme contrast between the audibility of lower notes and the comparative inaudibility of higher notes. It may be observed that deafness with maximum loss in the middle range seems to arise most commonly from middle ear disease; with maximum loss in the higher levels, from lesions or affections of the organ of Corti, and in particular from a partial atrophy of the portion of the auditory nerve that supplies the basal turn of the cochlea. Recent research, however, makes it clear that the correlation between the pathological cause of the trouble and the end-result as given by the curve of hearing is far too complex to be reduced to any simple rule. (See S. J. Crowe, S. R. Guild, and L. M. Poloogt, 'Pathology of High-tone Deafness,' *Bulletin of Johns Hopkins Hospital*, 1934, pp. 314–80; cf. *id.*, *Acta Otolaryngol.*, 1931, pp. 292–301.)

in learning to read; his pronunciation was still muffled and slurred; owing to a lack of natural intonation, his speech sounded flat and monotonous; and he possessed a characteristic lisp, due to the complete omission of sounds like *s* and *sh*. A subsequent test of his acuity for tones of different pitch revealed a marked loss of hearing for sounds above 2,000 vib. per sec. (about three octaves above middle C: see Fig. 8).[1] A similar but milder condition was suspected in several other cases; but it was impossible to subject them to a prolonged or detailed series of tests.

The diagnosis and treatment of this peculiar form of deafness can, indeed, be properly undertaken only by a specialist. It is, however, a possibility which the teacher should bear in mind, particularly in dealing with young children who enter the infants' school apparently incapable of speech. Such cases should always be referred for expert examination. The effects of the condition among older children I shall discuss more fully when I come to consider speech defects.[2] Here I need only add that, as a rule, children handicapped in this way seem to hear much better when they are spoken to in low tones. The teacher who imagines that they are deaf in the customary sense is tempted to shout; as a consequence, the loud fundamental note drowns or masks the higher overtones. He should remember, too, that the consonants that are hardest for such children to distinguish—*s*, *f*, and *th*—are among the easiest to interpret by observing the position of the lips. In these cases, therefore, lip-reading will be of special assistance.[3]

[1] The family doctor reported: 'At the age of 18 months [the boy] had an acute febrile attack, accompanied by convulsions, which I diagnosed at the time as meningitis. I considered him to be a case of aphasia, probably due to a consequent local injury to the brain.' An otologist who examined him at the age of 12 reported: 'The boy is certainly not aphasic and there is no other indication of cerebral injury. His deafness is probably attributable to impairment of the inner ear or auditory nerve, perhaps consequent on the attack of meningitis.' Under special training both his speech and general backwardness rapidly improved.

[2] See below, p. 385.

[3] For a fuller description of such cases, with suggestions for their diagnosis and treatment, see A. W. G. Ewing, *Aphasia in Children* (1930).

Treatment.—The detailed histories of the cases of ear trouble discovered in my survey indicated that much of the educational disability might have been prevented, and the defect itself very possibly cured, had the parent or teacher noted its presence during the initial stages. One of the most valuable services of the free school medical clinic in England has been the availability of steady and regular treatment for minor ailments such as these—ailments which, trivial as they may seem in themselves, may nevertheless, when neglected, culminate in major disasters to progress, health, and even life. The treatment should be in the hands of an otologist, or at any rate of a medical practitioner possessing an adequate knowledge of otological conditions. For otorrhœa and the like, the usual routine—regular cleansing followed by the instillation of antiseptic drops—seldom leads to a permanent cure. A relapse is exceedingly common ; and cases regarded as cured should still be kept under close observation in the classroom, and report from time to time at the clinic.[1]

It has generally been held that neither the 'partially deaf' nor the 'hard of hearing' can be profitably taught in the large classes of the ordinary school. Since, under ordinary conditions, they usually fail to receive the individual attention they require, the plan regularly advocated is instruction in schools or classes established expressly for such cases. The criterion given above—known sometimes as 'the six-foot rule'—is usually recommended to the teacher or medical officer who is considering what children are to be selected for transference.[2]

[1] For more detailed suggestions, see Macleod Yearsley, *loc. cit.*, XXXII, pp. 196 *et seq.*

[2] See above, p. 236. This criterion would include both the 'partially deaf' and the 'hard of hearing.' Other authorities have preferred to adopt a 'three-foot rule' for such a transference, on the ground that an intelligent child who is merely 'hard of hearing' can often make good progress if placed near the front of the class. Others advise special classes for the 'hard of hearing' and special schools for the 'partially deaf.' Many teachers, who remember readily enough the existence of special schools for the blind and mentally defective, seem often to forget the existence of similar provision for the deaf. Under section 52 (1) of the Education Act of 1921 it is a statutory duty of local education authorities to provide a special school, certified by the Board of Education as suitable for the education of deaf children within the area. It may be added that the first legislation

Here as elsewhere, however, the specialist is tempted to classify children according to the limited defect in which he himself is chiefly interested, and so to forget the importance of considering the needs and the situation of each individual child as a whole. No doubt, the removal of a child to a special school where the rest of the pupils are as deaf as he may largely help to compensate for the auditory handicaps that would hamper him in the ordinary classroom. But a psychologist is bound to point out that the general effect on the child's intellectual and temperamental development may be severely prejudicial. The psychologist's own policy is rather to encourage teachers and education authorities to deal with all children individually instead of merely classifying them into segregated types.

It is instructive to note what happens in those areas that make no special provision for the moderately deaf or in those cases where the existing provision has not been invoked. There can be little doubt that the majority of the children suffer. Nevertheless, here and there, it may often be observed that a child who is severely deaf is able, sometimes with, sometimes without, the aid of an understanding teacher, to make good progress in the ordinary school; and a study of the methods spontaneously adopted by the child or the teacher in such instances suggests that a great deal more could be done than is commonly assumed, apart from actual removal to a special school or class.

dealing with the need of special instruction for subnormal children was an Act providing for the blind and deaf—the Elementary Education (Blind and Deaf Children) Act of 1893.

There are nearly twice as many deaf children as blind: in London the special school accommodation is 654 and 352 respectively. But those considered 'partially deaf' do not seem to be so numerous as those considered 'partially blind': for these the special accommodation is in London 132 and 895 respectively. The London figures, however, are somewhat in excess of what could or would be enforced elsewhere; for the country as a whole the official estimates are, in round figures, as follows: totally deaf, 0·9 per 1,000; partially deaf, 0·3 per 1,000; totally blind, 0·4 per 1,000; partially blind, 1·0 per 1,000. But these, like all statistics relating to auditory defects, are highly unreliable. So far as the school population is concerned, the inquiries recently instituted by the Board of Education should do much to remedy this gap in our present information, and lead to more appropriate methods of dealing, not only with the severer, but also with the milder cases.

The one device that most teachers adopt is to put the child in the front row. This is the recommendation generally made by the school doctor ; and, as a rule, it is taken to mean that for oral work the child should sit as near the teacher as he can—in fact, immediately in front of him. But this is by no means the best position. Some hear better when they sit, not necessarily near to the teacher, but away from irrelevant noises such as tend to obscure their discrimination of speech ; others—particularly those suffering from middle ear deafness—often hear better in a background of sound, the irrelevant noise reinforcing the essential stimulus. As a rule, it is best to place the deaf child well to the side of the second or third row, with his sharper ear towards the teacher. Incidentally the side view of the teacher's face facilitates so-called lip-reading. In following what another person says, we all of us, far more than we commonly realize, use our eyes at the same time as our ears ; and the deaf should be expressly taught to watch a speaker's face. This is one reason why it is especially important to discover and correct visual defects as well as auditory in such children. But to look at the lips alone is not sufficient. What is popularly called lip-reading might be better termed speech-reading. It should include attention to the speaker's whole facial expression, to his gestures, to his head and eye movements, and not merely to the position and movements of his lips. Often it will be found that speech-reading is self-taught. In such a case the parent sometimes reports that the child suffers from 'night-deafness,' since he always hears best in the daylight ! These subsidiary aids, however, are less likely to be discovered by the duller children for themselves ; and during all oral work the less intelligent will require systematic help and supervision.

Another plan often exploited by the child is to appeal to his neighbour whenever he has not caught what the teacher says. Such informal assistance should be not only allowed, but positively encouraged. All too frequently the teacher, not realizing the value of the procedure, merely scolds the two for 'constantly talking in class.'

There are several minor points which a teacher who has a deaf child under his care should bear in mind. As a

general rule, oral work should be conducted in brief spells. Any prolonged straining of the attention is bound to produce intolerable fatigue, and may ultimately generate and justify a self-protective habit of indifference. Let the teacher consider his own experiences in listening to some preacher or lecturer whose words were barely audible, and recall how the effort to follow conscientiously for half an hour has left him over-wrought and exhausted : he will then realize what a tax is imposed, lesson by lesson and day after day, on the attention of the deaf child in the classroom.

The anxiety, the shyness, the diffidence and sense of stupidity bred by a memory of continual mistakes, must be carefully warded off. It is better for the teacher to strive always to make himself heard on the very first occasion than for the child to keep asking for a more audible repetition. In talking to deaf persons, it is far more helpful to speak distinctly, slowly, and with an even pitch and loudness, than to raise the voice. An indistinct enunciation is much harder to follow than a quiet enunciation : in a theatre or a large hall it is not the speaker who shouts that is easiest to hear. A high speed is even worse ; it not only leads to a slurring of consonants and a running together of different words, but leaves the hearer no time to analyse and take in what he has only partly caught. Those, too, who are deaf often find it difficult to accustom their ears to a voice which varies constantly in pitch. Casual parenthetic remarks, interjected on a lower note and in a quieter tone, they are apt to miss altogether ; and, though the remark in itself may have had no great importance, the listener is left puzzling over it and feels a hiatus in the conversation.

By scrupulously attending to these simple points the teacher in the ordinary school can do much to prevent what may seem a mild and perhaps a temporary defect holding up the child's whole education. Above all, he should remember that, doubtless because of the strain that is simultaneously inflicted on ourselves, we are apt to be far more impatient with the deaf than with the dim-sighted. Defects of hearing excite nothing like the sympathy, interest, and attention that are accorded to defects of vision. The blind

arouse our deepest pity ; the deaf are still regarded as little more than a laughing-stock or a nuisance.

To a large extent this is simply the result of ignorance and lack of understanding. Both on the theoretical and on the practical side there are still big gaps in our knowledge. Of the distribution of auditory defects among both the child and the adult population we know far less than we do about the distribution of visual defects. Early experiments in optics produced a simple apparatus which would correct the majority of visual defects; and it is now considered a duty to see that every child suffering from imperfect refraction is furnished with spectacles. But few education authorities provide hearing aids for the deaf. Within the last few years, however, physical research has led to the invention of amplifying apparatus which will intensify sounds for those who are dull of hearing almost as effectively as a lens will sharpen up the visual field for the dim-sighted. No doubt the existing instruments are clumsy, costly, and full of practical shortcomings. But with continued investigation many of the disadvantages could rapidly be removed. At the moment both the demand and the supply are unfortunately small. The facts and figures I have adduced above show clearly that auditory defects form a far greater bar to school progress than visual defects, and that, when recognized, the obstacles can to a large extent be overcome. It is time, therefore, that scientific and practical efforts should be concentrated on this problem.[1]

[1] *Note on Instrumental Aids.*—The manufacture and sale of apparatus for the deaf is still a commercial rather than a scientific undertaking ; and advertisers of such appliances exploit the disabilities of the deaf in ways which an optician would nowadays hardly think of employing in catering for those who suffer from bad sight. Aids to hearing, therefore, may first be classified, as one authority has already suggested, into those that are frauds and those that are not, and the latter may then be subdivided into those that suit the patient and those that do not. Suitability is the crucial problem, and depends on many different factors, psychological as well as physical. Every oculist regards it as an essential part of his duty to prescribe proper lenses : but the aural specialist, until quite recently, has, as a rule, taken little interest in matching apparatus to meet the needs of each individual. Teachers and parents, however, are beginning to appeal for information ; and it may be useful to indicate quite briefly the various types of instrument that are now available. Appliances for correcting poor hearing are far more rarely seen

and worn than appliances for correcting poor sight. Hence ear-trumpets and the like still elicit the same sort of ridicule as was provoked by spectacles when schoolboys first began to wear them a generation or two ago. Women and girls accept auditory appliances with greater readiness than men and boys, since they can camouflage them more successfully beneath their dress and hair. The teacher, however, could do much towards overcoming such prejudices, pressing for suitable apparatus where it is likely to be of real help and popularizing its benefits.

In the case of hearing it is not so easy to classify types of apparatus and types of defect on parallel lines, as can be done in the case of errors of refraction. In general, the pathological origin of the auditory defect is less helpful as a guide than its net psychological result as revealed by systematic tests and trials. From a physical standpoint, aids to hearing may be divided into (1) electrical and (2) non-electrical instruments; and both may be arranged to operate either (*a*) by air conduction, or (*b*) by bone conduction. As a rule, however, bone conduction is most effective with instruments of the electrical type. Instruments arranged for bone conduction may be of special assistance to those whose middle ear is severely damaged, while the inner ear is unimpaired; but most of the instruments in common use employ air conduction.

(1) Electrical appliances operate on the principle of the telephone: indeed, it may be remembered that the telephone was first invented by a professional teacher of the deaf, Alexander Bell, in the hope of helping his deaf wife to hear. As aids to hearing, such instruments either (i) possess carbon microphones constructed on the principle of the ordinary telephone, and operated by a small dry battery with a switch and a volume control, or (ii) contain valve amplifiers, working on the principle of a wireless set. So far as generalization is possible, instruments of the electrical type seem most suitable for those suffering from middle ear deafness—particularly the type of deafness where the patient can usually hear well on a telephone or where there is accessory noise. The microtelephones may be safely recommended for those whose maximum loss lies in the middle range, and are often satisfactory for those whose maximum loss lies in the higher range, provided the curve of audibility is not too steep. Instruments with valve amplifiers give a stronger and a better tone, but, until quite recently, have been made only in bulky form. The larger instruments of this type are well adapted for permanent installation in the special school; they can be arranged to lead to multiple receivers, so that one instrument can be used by several children at the same time. Apparatus for classroom use, in which binaural listening is made possible by the use of separate microphones, 4-stage valve amplifiers, and moving-coil or crystal telephones for the right and left ears respectively, has been designed by Dr. T. S. Littler in the Department of Education of the Deaf at Manchester University and is now in use at a number of schools for the deaf in Manchester, Birmingham, Sheffield, Derby, Bradford, and elsewhere. Smaller portable instruments with valve amplifiers are a comparatively new invention; they are not likely to be regularly used by any but the extremely deaf (*e.g.* those with a hearing loss of 60 decibels or more); with further progress in design, however, they will probably prove to

be of the greatest value. Electrical appliances are also now constructed with selective amplifiers; these will be especially serviceable to those who hear different parts of the scale with unequal clearness. But at the moment there are still very few small battery-operated instruments that are reliable or produced at a reasonable price. Although considerably augmenting the volume of the sound, most of the electrical instruments, particularly the microtelephones, introduce a large amount of distortion. Miss Kerridge relates how one child, when using such an instrument, told her that it made the teacher 'sound like a movie star.' Persons who try out such apparatus generally pay too much attention to the magnification of the sound and too little to its quality.

(2) The non-electrical instruments collect sound, magnify it by resonance, and convey it right into the ear. They are made in various shapes and sizes—horns, trumpets, speaking tubes, auricles, and so on. Such appliances increase the loudness of the sounds only by about 15 decibels, and are therefore suited rather to the milder cases—but these, after all, are a majority. On the other hand, the tones of conversation are conveyed with a far more natural effect. Such instruments may be especially helpful in cases of inner ear deafness and in those where high notes are badly heard, since they magnify sounds of a high pitch more intensely than those of a low pitch. At present, it may, I think, be said that of all the appliances available the earlet—a simple horn with no electrical amplification—is still the lightest, cheapest, least conspicuous, and most effective instrument for the greater number of cases.

A simple pamphlet on *The Choice of a Hearing Aid*, approved by the Hearing Committee of the Medical Research Council, is issued by the National Institute for the Deaf, 105, Gower Street, London, W.C.1. The Institute also keeps a list of the more reliable firms. On the whole subject the teacher may usefully refer to the article by Dr. Kerridge on 'Can Physics Help the Deaf Child?' (*Lancet*, 1935, Jan. 12, pp. 104 *et seq.*); the medical officer will find a suggestive review in the Symposium on 'Affections of the Ear' in the *Practitioner* (CXXXV, 1935, pp. 641 *et seq.*).

CHAPTER IX

MOTOR DEFECTS

Motor Capacities.—It is a truism in psychology that the mechanism of the mind stands on a sensori-motor basis. The world outside can stimulate the mind only through one of the senses ; and, in return, all that the greatest intellect can do is to contract a set of muscles and move a set of bony levers. The end-product of every mental process is simply a muscular reaction. The chief avenues of sense-perception we have already discussed ; we have next to consider the different forms of motor response. And so we turn from eye and ear to hand and tongue.

Manual Disabilities.—' Man,' as Carlyle has told us, ' is a tool-using animal with the gift of talk.' From the lowlier creatures he is distinguished almost as much by the skilfulness of his fingers as by the facility of his tongue—by his power of manipulation as by his power of speech. Hence, manual *dis*abilities, no less than speech defects, may gravely retard the growing child's attempts to acquire and use the benefits that his civilized forerunners have achieved.

The teacher, himself a member of a scholastic profession, tends naturally to over-prize scholastic accomplishments—skill in employing and understanding words, written, spoken, or printed : the value of skill in more practical directions he is prone to forget. Of late, however, and partly by way of a reaction, handicraft has been introduced more and more into the curriculum ; but the profound individual differences in these humbler forms of ability are still overlooked. If we hear of exceptional peculiarities in this respect, it is special manual dexterity, not special manual inefficiency, that is generally stressed. Yet manual or motor disabilities are quite as common as manual or motor gifts ; and it is unreasonable to assume that all children will be equally

capable of profiting by the addition of handwork to the syllabus. This is especially true of the backward for whom handwork is sometimes advocated as the supreme educational need. Accordingly, in discussing the motor capacity of the backward child, I shall first consider the testing of manual dexterity and the discovery of special disabilities affecting the movements of the fingers and hands ; and I shall then turn to the problems of motor inco-ordination where other muscles are mainly affected.

Motor Tests.—We have seen that, on the basis of test-results, psychologists have sometimes supposed that they could distinguish between a ' verbal ' and a ' non-verbal ' or ' manual ' type of child. The designations are not well chosen, but their meaning is sufficiently clear : the verbal type does better in tests conducted through speaking, reading, or writing words ; the non-verbal type, it is generally implied, does better in tests depending on manual activities. Among teachers and laymen, there is an analogous notion, still more widely circulated, that children who are backward in the academic lessons of the regular school curriculum—reading, writing, calculating, and all forms of bookwork—may yet excel in handwork and in tasks of a more practical kind. This no doubt is one of the chief reasons for the common view that, in special schools for the defective and in special classes for the backward, the training best suited to all retarded pupils will be a training along manual lines.

The surest way to verify an assumption such as this would be to apply standardized tests of motor capacity, and compare the results with the pupils' intelligence and with their attainments in other subjects. Unfortunately tests for motor capacity have not been so thoroughly worked out as the accepted tests for hearing and vision ; and considerable difficulties attend their use outside the psychological laboratory by the teacher in the school. Yet occasionally the addition of some such test, however inexact, will shed much light upon the relative abilities of the backward child ; and every teacher should know something of the various aspects that may be measured.

The specialized tests themselves take far too long to be applied as a routine procedure to each individual. Ordin-

arily, the more essential processes can be observed incidentally during tests of handwriting or drawing. As a subordinate part of my inquiry, however, I systematically tested about 100 representative boys and girls (50 of each sex) in both the backward and the normal groups. These were nearly all between the ages of 10 and 12. The results are summarized in Table XVI.[1]

TABLE XVI. TESTS OF MOTOR CAPACITY

	Control Group.			Backward.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.
1. Muscular strength .	104·3	98·3	101·3	99·1	92·7	95·9
2. Muscular endurance .	101·2	92·1	96·7	97·2	87·5	92·4
3. Speed of movement .	96·6	93·1	94·9	94·8	90·1	92·5
4. Accuracy of movement .	98·1	92·2	95·2	88·7	89·1	88·9

1. *Muscular Strength.*—For tests of strength the ordinary dynamometer was used. It is an oval spring of steel, squeezed in the hand, and calibrated to register the grip in kilograms or pounds. For rough purposes, where no quantitative assessment of the strength of hand and fingers is required, it may be sufficient to note what happens when the

[1] For the technique of such tests and for age-norms see Whipple's *Manual of Mental and Physical Tests*, pp. 93–164. My own procedure followed, as far as possible, the methods there described. Age-norms are furnished by Whipple only for certain tests; and, owing perhaps to slight differences of procedure, seemed often inappropriate for London children. Accordingly, the same tests were given to median children at each age, and the annual curve of progress smoothed. The children selected for this purpose were average boys from typical schools outside the control group. The scores obtained with each test were then converted into mental ages; and, for the sake of comparability with other results, the figures are here given in the form of mental ratios. Throughout, the girls' results are expressed in terms of norms obtained from the boys in order to bring out sex-differences. The standard deviations average about 10 points on the scale of mental ratios. With groups of 50, therefore, the standard error of the differences will be about 2 points. Consequently, between the two sexes the differences are not significant unless they exceed 4 points. Between the averages for the backward and the control group all the differences are significant. For help in this part of the work I am especially indebted to the assistants named above (p. 107). The full details of the research I hope to publish in a separate article.

child shakes hands, or when he tries to squeeze your fingers at his hardest. For estimates of more general physical strength, the most useful are the familiar jumping tests: the child is required to jump first as high as possible, and then, after a complete rest, to keep jumping as rapidly as possible for 15 seconds without stopping.[1]

Since, as we have seen, backward children tend to be weak in general physique, we should naturally expect to find them feeble in the muscles of their hands and fingers. Between the backward and the normal groups, however, the average difference proves to be small. The marked inferiority apparently revealed among a few of the dull (and exceedingly common among the mentally defective) is not entirely due to muscular weakness; it springs largely from a lack of general energy and an incapacity for voluntary effort. In most children, the right hand is appreciably stronger than the left—usually by about 7 or 8 per cent. But in the dull the difference between the hands is far less marked than it is in the normal.[2]

2. *Muscular Endurance.*—To measure muscular endurance and fatigue, the child is required to squeeze the dynamometer continuously for one minute, and then (after a rest) 16 separate times at intervals of 4 seconds. Apart from the actual pressure reached or sustained, the course of the curve of the pressure—whether stationary all through, rising throughout, steadily falling to the end, or falling at first and then stationary—is very frequently suggestive. The ergograph—a laboratory instrument that has obtained some notoriety for the purpose of measuring work and fatigue in this way—proves cumbrous and unsatisfactory with young children. If special appliances are not available, the child may be required to hold a heavy object out at arm's length, or to stand as long as he can on tip-toe.

[1] In considering a single jump, the height to which the head rises is the best criterion. Weight and stature can be allowed for by the formula $\frac{\text{Jump} \times \text{Weight}}{\text{Stature}}$. With repeated jumping a comparison of the pulse-rate before and after the jumps, and the speed with which it returns to the normal, incidentally afford a good test of physical fitness.

[2] The figures in the table are based throughout on right-hand measurements with right-handed children and left-hand with the left-handed.

Could the results of my tests be taken at their face value, it would seem that the backward child shows fatigue far more quickly than the normal, but that he fatigues less easily with muscular tests than with mental tests. Yet this apparent fatigue, even with a simple test of hand grip, depends on many complex factors ; and the figures are not so conclusive as might be supposed. If all the individuals of a nervous, temperamental, or delicate type were excluded, there would be no discernible difference between the averages for the dull and the averages for the normal. With the mentally defective, fatigue will often betray itself more patently by slight involuntary movements and by an extreme unsteadiness ; but these are not so distinctive of the dull. Here again, however, the value of the test lies less in the actual record, and more in the way the individual child faces and fulfils the test-requirements.

3. *Speed of Movement.*—Speed is most conveniently measured by some form of tapping test. In group-testing the child is required to tap with a soft pencil on squared paper, one dot in each square, or to make holes with a blunt pricker in squared paper resting on a thin piece of felt.[1] In individual testing he may be required to tap with his own finger on an automatic counter. The tapping or the pricking is to be done as rapidly as possible. Here I have used chiefly the pricking test.

So far as the results can be trusted, they indicate that the dull child is also as a rule a slow child ; while the merely backward, if health and intelligence are normal, are quite up to the average in quickness of simple movement. With tests of speed the index of left-handedness (efficiency of the left hand expressed as a percentage of the efficiency of the right) is, at any rate among children, somewhat lower than with tests of muscular strength : 85 per cent. as compared with 92 per cent. The movements of the right hand are approximately 17 per cent. quicker than those of the left.

Whether speed of reaction is a general mental factor or

[1] For details as to method see my early paper, *Brit. Journ. Psych.*, III (1909), pp. 94–177. For measuring the speed of single reactions I have found the portable d'Arsonval chronometer most convenient for school work.

not, has been debated again and again. Many psychologists have claimed that, in one and the same individual, speed in any particular mental function may be wholly independent of speed in the rest. Among school children my own figures go to suggest that there is in fact some kind of fundamental tendency, and that the dull are not merely slow in finger-movement, but slow all round. In the main, however, the tendency seems temperamental rather than intellectual. The emotional, excitable, extraverted child is generally slap-dash: he walks quickly, talks quickly, eats quickly, scribbles quickly, and, indeed, executes almost every movement at a high impulsive speed. The unemotional or apathetic, and sometimes also the introverted and repressed, appear characteristically lethargic in nearly all their thoughts and actions.[1]

Sometimes it is important to assess, not only the child's power to make movements, but also his power to refrain from them, in other words his capacity for keeping still, or at any rate for avoiding wrong or unnecessary movements. A simple and suggestive observation, especially in nervous and temperamental cases, is to require the child to stand motionless, with heels and toes together, and with eyes first open and then closed. For observing more particularly the steadiness of the hands the child may be told to extend his arms in front of the body, with the palms horizontal and turned downwards: tremors too fine to be seen can often be felt if the child's finger-tips rest lightly on the examiner's palms.

These, however, are but rough preliminary methods, although to the practised physician they may yield plenty of information. Where it is desirable to measure steadiness of hand more exactly, the child may be asked to take a pencil and draw a line between two ruled lines that are nearly parallel but approach each other more and more closely towards one end. Unsteadiness is then indicated by the number of times the child involuntarily touches these margins.[2]

[1] See below, p. 555.

[2] Cf. Whipple, *loc. cit.*, Test 12; also W. C. Bagley, 'On the Correlation of Mental and Motor Ability in School Children,' *Amer. Journ. Psych.*, XII (1901), pp. 193–205. In the original form the 'pencil' and the edges of the path were of metal and the errors or contacts were recorded electrically.

This or some similar test I have regularly used in those special cases where an inability to control and steady the hand seemed likely to hinder the child in certain types of school work. It is interesting to note that several of the most unsteady children discovered in this way were later diagnosed as suffering from mild or latent chorea. It may be added that the 'tracing test,' as it is sometimes termed, brings out, far more strikingly than the tests of strength or speed, the differences between the two hands: the right hand is, on an average, steadier than the left by about 16 per cent.

4. *Accuracy of Movement.*—More important than any of the aspects so far mentioned—strength, speed, or steadiness—is the accuracy of movement when guided by the eye. For this I have employed two tests—a sorting test and an aiming test. In the first the child is required to deal fifty cards as rapidly as possible into five piles according to their colour. In the second a paper tape, marked with an irregular series of dots, is placed in front of the child, and he is required to hit each dot with a pencil at a standardized rate.[1] A modified form of this test has been devised by Muscio: each dot is ringed round like a target with a bull's eye. The child taps or pricks in time with a metronome. Ordinarily a dozen little targets are printed or hectographed on a single sheet: but for reliable results I find that a strip of at least fifty is required.

The tracing test just described for measuring simple steadiness may be modified so as to increase the amount of visual control, and may thus be employed as a test of precision. The path to be followed between the nearly parallel lines, instead of being straight, is bent into zigzags or curved into scrolls. If the whole is arranged in the semblance of a maze, the child's interest is more keenly aroused, and excellent results are obtained. Square mazes and circular mazes may both be used. In each the path is spiral, and should run clockwise in one half, and counter-clockwise in the other. The path itself gets narrower and narrower, but, unlike the more familiar mazes of the Porteus type, shows no side-turnings. The child's task is simply to draw his pencil

[1] See *Brit. Journ. Psych., loc. cit. sup.*

down the narrowing, winding path without touching the sides or 'walls.' [1]

To check precision of movement, when the movement is guided not by vision but by the muscle-sense, the child may be required to close his eyes and to trace a maze with his finger: the path is indicated by a groove or bent strip of wire. If the necessary apparatus is not procurable, he may be asked to draw a square blindfold, or to sketch a face and insert the eyes, with his own eyes closed. Another rough and rapid test is to tell him to touch in quick succession his nose, the tip of the opposite ear, and the tip of the middle finger of the opposite hand, first with one hand and then with the other: surprising failures are often seen in neurotic cases. But once again it is perhaps necessary to remind the inexperienced reader that crude observations of this sort are of value only as a starting-point for further inquiries and more accurate tests.

On comparing the results obtained with the whole series of tests I have mentioned, it would seem that the backward fail most of all in tasks requiring exactitude of eye-and-hand co-ordination (see Table XVI above). With children of this type accuracy of controlled movement is decidedly more deficient than strength, steadiness, endurance, or even speed. Nevertheless, the difference is seldom large. Generally speaking, as we shall learn later, the backward group differs much less in motor capacity than in higher mental processes, but, so far as they differ at all, they are inferior to the normal, not superior. There is thus no valid evidence whatever to confirm the popular notion that the child who is backward intellectually may yet find compensation in superior manual gifts. With tests of accuracy the general efficiency of the right hand is still more marked: the average index of left-handedness is 78 per cent.

The sex-differences are noteworthy. In both normal and backward groups the girls are poorer in muscular strength and endurance. In accuracy but little sex-difference is per-

[1] This modification, I believe, is due to Dr. L. S. Hollingworth. It was suggested to me by one of my American research-students; and has since been described by W. N. Durost, 'Group Tests of Manual Laterality,' *Genetic Psychology Monographs*, XVI, No. 4, pp. 257 *et seq.*

ceptible: among the backward, indeed, the girls appear slightly superior in accuracy, but the difference is too trifling to be truly significant. On the other hand, in strength and endurance the weakness of the backward girls as contrasted with the backward boys stands out as one of their most salient characteristics. The superior strength of the boys in the control group, when compared with the normal standard, is doubtless due to the fact that many from the poorer social classes have been regularly engaged in heavy muscular work.

Tests of Manual Subjects in the Curriculum.—In the class-room motor disabilities show themselves most plainly in what are called the manual subjects—writing, drawing, sewing, and the various forms of handicraft. By incapacitating the child for efficient work of this kind they tend to retard his school progress in numerous directions. Achievement in the subjects mentioned may be readily measured by standardized tests such as I have described elsewhere in dealing with the different branches of the curriculum. All the children in my groups were tested for drawing and writing in this way; in addition the girls were tested for sewing, and the boys, as a rule, for simple handwork.[1]

The results of scholastic tests for manual subjects tally with the conclusions just drawn from the psychological tests for the elementary motor functions. In handwork, in drawing, and above all in writing, the dull and backward fall demonstrably behind the normal. The differences, assuredly, are smaller than in the more academic branches of their work; yet they are greater than we might be led to expect from the psychological tests of motor capacity taken by themselves. Clearly these acquired dexterities depend largely upon intelligence, as well as upon mere quickness and accuracy of movement. The children in the control group, it will be noted, fall but little below the level of their motor capacity (cf. Table XVII).

[1] The tests employed were Tests 15, 16, 17, and (for boys) 19, as described in *Mental and Scholastic Tests* (pp. 308–28). With girls tests of needlework were used instead of Test 19 (cf. *ibid.*, p. 329).

TABLE XVII. TESTS OF MANUAL SUBJECTS

	Control Group.			Backward.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.
1. Handwriting:						
Speed	92·5	94·4	93·5	80·2	82·4	81·3
Quality	90·6	91·2	90·9	77·8	83·7	80·8
2. Drawing	91·0	95·3	93·2	82·4	85·6	84·0
3. Handwork	97·1	101·3	99·2	88·7	87·4	88·1

As we have seen, it is repeatedly alleged that the child who is backward in the formal subjects will shine and even surpass his schoolfellows in manual subjects of this sort, and that, while some pupils learn best through words and not at all through handwork, others can not only learn more effectively but also express themselves more effectively with their hands and fingers, and hardly at all through language. The testing of motor capacity threw some doubt on these assumptions: the testing of manual attainments yields a final answer. The results show plainly that such generalizations are inaccurately stated. Here, as in the tests of the more academic subjects, the backward still occupy a place that is roughly midway between the normal and the defective.[1] The backward child, like the defective child, seems good at handwork only by contrast with his own poor performances in reading, spelling, and arithmetic, not in comparison with the handwork of the normal. Certainly, as I have already stated, something like a manual type and a verbal type can here and there be distinguished. But, if I may trust my own experience, any clear-cut example of a one-sided 'type' is exceptional and rare. To sort out the whole school population into one or other of these two classes would be impossible, and to identify the backward child with the 'manual' or 'practical type' would be altogether absurd.

[1] Figures for mentally defective children are given in *Mental and Scholastic Tests*, p. 337.

CHAPTER X

LEFT-HANDEDNESS

I. *Methods*

Complexity of the Problem.—Of all the special motor disabilities found among school children, that which interferes most widely with the ordinary tasks of the classroom is left-handedness ; and no question is put by the teacher to the school psychologist more frequently than this : 'How should I deal with a left-handed pupil ?' A condition so common and so perplexing will require examination at some length.

One fact must be emphasized at the outset. Left-handedness is by no means so definite a characteristic as is popularly supposed. Right-handedness and left-handedness are relative terms—indeed, somewhat ambiguous terms, not sharply defined alternatives, mutually exclusive and absolutely opposed. To describe a child as left-handed without further explanatory details conveys very little information about his manual habits generally and still less about his neuro-muscular co-ordination as a whole. Usually it simply means that the teacher has observed the child regularly writing with his left hand, and is tempted to infer some inherent and abnormal asymmetry in his nervous organization or brain.

Closer inquiry soon reveals that left-handedness can manifest itself in very different forms and with very different degrees of strength. Moreover, the mixed forms and the milder degrees prove quite as common as the thoroughgoing or extreme. How many persons are consistently left-handed—or, for that matter, consistently right-handed —for every transaction in which hands are required ? We shall find ample evidence to show that, quite apart from any general inclination such as might be ascribed to an innate

or hereditary tendency, individual preferences in this movement or in that are dictated now by habit, now by special circumstance, and now by the intrinsic delicacy of the muscular co-ordinations involved. Accordingly, mere casual observation of some particular stereotyped action, like writing or drawing, will be of little value by itself: such observations need to be supplemented by an inquiry into the conditions under which the action has been learnt, and by specially devised tests which will estimate the strength of any original or ineradicable bias.

Definition and Tests.—Before we can devise a proper test, we must clarify our conception of what left-handedness denotes. An exact definition is essential. By left-handedness [1] I understand a consistent tendency (whether congenital, or induced post-natally by accident or by some other change in the hand or its neuro-muscular apparatus) to undertake new dexterities with the left hand rather than with the right. It must be judged, therefore, not so much by long-standing habits as by an unfamiliar task, and not by a single action, but by several. The points to observe are not merely the child's customary mode of using the pencil or pen, but his power to throw a ball or pick up a weight, to hammer or bore, to sort marbles, deal cards, cut with a knife or scissors, stir with a teaspoon in a cup, turn a handle or wind cotton round a reel, more easily with the one hand than with the other. Probably the best single test for rapid use is to ask the child to cut paper with loose-riveted scissors.[2] Incidentally it is at times instruc-

[1] The etymology of the word is suggestive. In the present sense the word 'left' is not connected, as is so often supposed (*e.g.* by Webster's *Dictionary*, s.v.), with the verb 'to leave.' It is derived from the Anglo-Saxon 'lyft' = weak, broken (akin to 'lopt' or 'lopped,' and possibly to the German 'licht' and 'leicht,' and to 'light' in the sense of fragile). Thus to the Saxon the left arm meant the weak arm: to the Latin and the Greek (if we may trust the usual derivation) the left hand meant the shield hand (*laeva*, λαιά—archaic and poetic words), or, later on, the pocket hand (*sinister*, a less poetic word, from the 'sinus' of the toga). These designations, as we shall see in a moment, might almost be taken as emblematic of the two contrasting theories of the function of the left hand in man.

[2] In their earlier experiments investigators relied solely or mainly upon the dynamometer. The data collected by the Galton laboratory and analysed by Pearson and Woo were based on strength of grip; and similarly with much

tive to make a note of any half-unconscious manual habits that are not influenced by social pressure. For example, in clasping the hands, which thumb is placed on top ? And—perhaps a little more significant—in folding the arms, which hand is placed on top of the opposite arm ?

If quantitative measurements are required, any of the tests of manual dexterity described above may be employed. The child carries out the test first with the hand that he usually writes with, and then with the other. The index of left-handedness most commonly adopted (generally, but inaccurately, termed ' index of right-handedness ' or ' dextrality ') is given by the simple formula $\frac{L}{R} \times 100$, where R and L denote the number of marks scored with the right hand and with the left respectively ; a somewhat better measure of right-handedness is given by the formula $\frac{R - L}{R + L}$.

So important is it to detect tendencies towards left-handedness at the earliest possible moment that a word or two may be added on the testing of young infants. The critical period lies between six and fifteen months. At this tender age a rough ' reacting test ' is the easiest to apply. Provisionally, in default of first-hand studies in this country, I suggest that the experimenter should adopt the procedure and the norms worked out by Gesell in America. ' A red rod ' (*e.g.* a red pencil) ' is held in the median plane, and the child is encouraged to make repeated efforts to grasp it.' With the shy, the dull, and the mentally deficient, a sweet wrapped in coloured paper is sometimes more effective. The examiner is also instructed to note ' whether the child uses one hand independently in his own spontaneous manipulations '—*e.g.* in picking things up or flinging them down.[1]

of the evidence in regard to primitive races. But the dynamometer is primarily a test of strength ; whereas right- or left-handedness as I have defined it turns primarily on capacity for skill. I find that as many as 41 per cent. of those who habitually use the left hand for skilled actions nevertheless have a stronger grip with the right (see also Whipple, *loc. cit.*).

[1] *Mental Growth of the Pre-School Child*, p. 80. Something a little more

Right- and Left-handedness in Two-handed Operations.—With older children more recent investigators have urged that tests such as I have mentioned, which they regard as tests of uni-manual activities only, should be accompanied by tests and inquiries upon bi-manual activities.[1] These they divide into two sub-groups on a basis which at first sight seems purely empirical. The typical activities chosen are (i) throwing a ball (for the uni-manual test), and (for the bi-manual tests) (ii) using a cricket bat, a golf club, or an axe, and (iii) using a pitchfork, a shovel, or a broom—the use of the bat and the broom being generally taken as the most representative. A ' handedness formula ' is then proposed which will indicate, by three letters, each individual's habits in each of the three directions. Thus if he (i) throws with his right hand, (ii) bats with his left, and (iii) sweeps and digs with his right, he is classed as R L R. But what are we to regard as ' right-handed ' batting or sweeping, when by hypothesis both hands are used ? The criterion proposed is the hand which is held ' nearer the business end of the instrument '—that is, the lower end, the end farthest from the shoulders.

To me this latter principle appears quite mistaken. The real question is—which of the two hands executes the greatest movement and consequently undertakes the more delicate and more active task of guiding or directing the instrument ? In batting, as in wielding a hockey stick or golf club, the fulcrum is near the body, and the ' business end ' executes the wider movement. The right-handed batsman, there-

precise and detailed, however, is urgently needed in regard to both methods and results. Miss Woolley's method (*loc. cit. inf.*)—placing two coloured discs side by side in front of the child—though adopted by many early investigators, seems still less satisfactory. It yields one fact of theoretical interest : with this procedure one can often observe a definite tendency to look towards the disc on the right quite apart from any movement of the right hand.

[1] The suggestion seems first to have been put forward by J. Merle Rife (' Types of Dextrality,' *Psych. Rev.*, XXIX, 1922, pp. 474–81). An extended investigation along these lines, made with the aid of a grant from the American National Research Council, is described by June E. Downey, ' Types of Dextrality and their Implications,' *Am. Journ. Psych.*, XXXVIII, 1927 (pp. 317 *et seq.*).

fore, almost always places his right hand below the left. But in sweeping or digging it is usually the nearer end of the broom or spade that is chiefly moved. With the broom, it is true, various methods may be adopted. But in digging the movements are fairly uniform: the left hand generally holds the middle of the spade and supplies a fulcrum; the right hand moves the handle to balance the heavy earth at the other end. Should we call the ordinary method of using a billiard cue 'left-handed' because the left hand is 'nearer the business end'? With each of these instruments, apart from special conditions (*e.g.* sweeping in awkward corners), the dominating tendency is for the operator to work always on the same side of the body. Thus a right-handed person keeps the handle of the bat, broom, or spade mainly on his right. It follows that the relative positions of the two hands on the handle will naturally be inverted for swinging and for thrusting movements respectively—for swinging as in using a cricket bat, and for thrusting as in sweeping, digging, or striking with a spear or pushing with a cue.

If these observations are correct, the third letter in the usual 'handedness formula' should evidently be reversed: R R L should be called R R R, and so throughout the series. And, in point of fact, the figures given by all investigators show that, in using the spade or broom, the vast majority of persons, who are otherwise right-handed, place the *left* hand down—*i.e.* 'nearer the business end.' It seems wholly illogical to designate this a left-handed procedure.

Manual Types.—Those who lay stress on the difference between bi-manual and uni-manual operations believe that we must recognize a number of clear-cut types. Instead of splitting the whole population into two simple categories, the right-handed and the left-handed respectively, there are, they assert, at least half a dozen subdivisions. Each type is different in nature, and calls for a different treatment in the classroom. Hence they argue that all the earlier work on left-handedness as it affects the child at school is invalidated from the outset. It over-simplifies the problem.

Their detailed classification follows from the formula

given above. A twofold division, as we have seen, is applied and re-applied on three successive principles. In theory this should furnish $2^3 = 8$ possible types. But in practice, it is said, 'there is no such combination as R L R and L R L. . . . When a man is seen throwing with the right hand and batting with the left hand, then it is certain that he will sweep and pitch hay with the left hand.' Hence we are left with only six.[1]

The suggestion emanates from America, where most of the more recent inquiries have been carried out. To check their deductions, and to verify my own hypotheses, I have collected the following data from English adults. The right-handed persons were mainly post-graduate students at a training college; and to obtain a larger number of left-handed types I have extended my investigations to all the alleged cases of left-handedness I have encountered at public lectures or in private life. The following table summarizes the chief results (Table XVIII).

TABLE XVIII. FREQUENCY OF VARIOUS RIGHT-HANDED AND LEFT-HANDED TYPES

Right-handed for Uni-manual Operations.				Left-handed for Uni-manual Operations.			
Operation. (i) Throwing (ii) Batting (iii) Sweeping (Burt) (iii) Sweeping (Rife)	Men.	Women.	Both Sexes.	Operation. (i) Throwing (ii) Batting (iii) Sweeping (Burt) (iii) Sweeping (Rife)	Men.	Women.	Both Sexes.
R R R (L)	47·0	51·2	49·0	L L L (R)	26·5	40·3	32·2
R R L (R)	42·3	29·1	35·9	L L R (L)	24·1	31·6	27·1
R L R (L)	8·8	14·8	11·7	L R L (R)	44·6	24·6	36·4
R L L (R)	1·9	4·9	3·4	L R R (L)	4·8	3·5	4·3
Total .	100·0	100·0	100·0		100·0	100·0	100·0
Number.	215	203	418		83	57	140

[1] Rife, *loc. cit.*, p. 477. No figures, however, are given in support of this assertion. According to my own results (cf. Table XVIII, last line), the rejected combinations, though rare, are by no means non-existent.

At first sight the variety of combinations appears somewhat bewildering. They are largely accounted for when we look more closely into the nature of those two-handed activities that are taken as the basis of the sub-classification. As we have already seen, the movements in the first set (using a bat or a golf club) involve a swinging stroke, carefully aimed and skilfully applied : they are, in fact, difficult and dexterous operations ; moreover, they are learnt and practised in teams or social groups ; hence nonconforming methods are apt to be quizzed and criticized until they are brought into line. The activities in the second set (sweeping and digging) are by comparison coarse and unskilled processes : as usually carried out, they involve a push or thrust, and demand strength rather than precision. They are generally undertaken alone ; hence individual oddities may pass uncorrected.[1]

[1] Generally speaking, with the unsophisticated sweeper the natural movement in pushing a broom is rather like the movement in pushing a billiard cue, a bayonet, or a spear. The butt end tends to swing back past the body ; the active hand is therefore nearer the butt. That this is the main factor in determining the relative position of the hands in sweeping may be seen on contrasting it with the opposite motion of paddling. In paddling a canoe it is the blade and not the handle that comes back past the body ; consequently, the active hand must now be nearer the blade, while the other hand rests on the butt end. This resembles the position in batting, except that, since the strong stroke is now a backward pull instead of a forward drive, the palm curves round the front of the handle instead of round the back. For efficient sweeping indoors, however, some skill is required ; and the movements, and consequently the hand positions, may often be altered according to the part of the room to be swept. Indeed, many women consider themselves ambidextrous for sweeping. Further, at housewifery classes, sweeping is generally performed under criticism and instruction. Hence girls tend to adopt a more conventional and therefore a more nearly unanimous position. In sweeping indoors the girl is usually instructed to pull or draw rather than to thrust or push, and to press and keep the bristles down rather than to fling them (and the dust) up and away. The position of the hands relative to each other will usually remain the same ; but (and this is a point that is missed by psychological writers) the same position of each hand relative to the handle is now reversed : the left palm is now nearly always placed *over* the handle, and the right usually under it, because the ' business end ' has to be pressed *down*—a motion which is given best by the left hand with right-handed persons. In lifting the ' business end ' of such an instrument *up* (as in using a pitchfork) the left palm will be *under* the handle and the right usually above it. In thrusting (*e.g.* in striking with a spear) the palms are usually at the

The following conclusions, suggested by the figures in the table, will now become intelligible.

(i) The commonest type of all is the type that is consistent throughout.[1] The right-handed tend to be right-handed for all the operations tested ; the left-handed (except for male cricketers) tend to be left-handed. But the tendency is far from universal : taken together, the exceptions are more numerous than the rule. (ii) In the main, it is the degree of skill required, much more than the number of hands involved, that determines how the hands shall be used. Thus hand-preference is much more likely to vary in the different two-handed operations, which may be either skilled or unskilled, than in different skilled operations, which may be either one-handed or two-handed. It follows that, among right-handed and left-handed alike, the preference in skilled two-handed activities, such as batting, nearly always follows the preference in one-handed activities, such as throwing. The only noteworthy instance to the contrary is that of right-handed batting among left-handed men, which is explicable by social pressure. (iii) Among the many who consequently employ the same hand for all difficult or delicate movements, whether the total operation is of the one-handed type or of the *skilled* two-handed type, the procedure adopted for operations of the *unskilled* two-handed type is fairly well divided. Some keep the skilled hand near the business end, so preserving the same position for all two-handed operations, skilled or unskilled, and

side. Observe that, when a right-handed man thrusts, the positions of his hands, both as regards each other and as regards the surface of the handle, are very similar to those adopted when a left-handed man bats. Hence the man's method of holding the more familiar bat often influences him when he comes to handle the less familiar broom, for the male method of sweeping is generally to thrust or shove : and thus he is sometimes tempted to sweep left-handed. Similarly, the woman's method of holding the broom often influences her when she comes to pick up a bat. These somewhat thoughtless and awkward positions, assumed with unfamiliar instruments, are especially noticeable among those who are less efficient in novel activities of every kind, *i.e.* among the less intelligent.

[1] This may seem at first sight to contradict Rife's statement that 'the type which throws, bats, and uses the spade right-handed . . . seems to be the least common' (pp. 474–5) ; but it must be remembered that what Rife terms a right-handed use of the spade is here regarded as left-handed.

holding brooms as though they were bats. Others, more appropriately, keep the skilled hand near the guiding end—that is, near the free end of the handle, and so follow out their one-handed tendency; this practice is commoner among the women—no doubt because for them sweeping is a relatively skilled operation. (iv) Among the right-handed, those who throw with one hand and bat with the opposite are distinctly scarce, especially when the batsman is a male. Among the left-handed they are more abundant, and, indeed, with the males provide the commonest type. These latter are mainly men in whom a left-handed tendency is present to a mild degree: for batting they have learnt the orthodox right-handed fashion, but have kept or cultivated a left-handed method for bowling, throwing, and tossing.[1] (v) Finally, when a person uses opposite hands for one-handed and for skilled two-handed operations respectively, the procedure which is most consistent with both of these practices is almost invariably adopted for unskilled two-handed operations: *e.g.* the man who throws with the left hand and bats with the right, will use his left hand to guide a broom in sweeping and keep his right hand down on the handle—thus holding the broom much as he holds a bat.

I conclude that we cannot regard these differences as signalizing fundamentally distinct or basic types. The right- or left-handed aptitude, whichever it may be, tends to dominate throughout, though in differing degrees with different persons. When comparatively weak, it may be easily overcome by circumstance or tradition, and may never come definitely into play in activities that require little skill and can be performed in various ways according to the conditions of the moment (as, for example, wielding an axe or a broom). When strong, it may influence every action.

How far do these considerations affect inquiries on children of school age? Plainly, among boys and girls of the class we are studying, it would be all but useless to attempt such classifications. Among the elementary school

[1] In golf, it may be noted, and in mowing, the right-handed form of the club and scythe often compels the learner to follow the traditional method. It is true that golf clubs and cricket bats exist for the left-handed; but I have never heard of a left-handed scythe.

population in London few of the girls play cricket or hockey; and not many of the boys use a shovel or a broom. So far as my observations go, the younger boys at cricket and the younger girls in sweeping seem to follow almost without exception their one-handed preferences. The older left-handed boys who play under the supervision of a master are usually taught to comply with the traditional practice; and the older girls who attend housewifery classes accept the methods of mopping and sweeping in which they are instructed. Though the degree of skill achieved by a left-handed child with a right-handed method is admittedly a little poorer, in neither case does there seem to be any irksome struggle in making the adaptations required. Doubtless because no fine accuracy is imperatively demanded, there is nothing like the conflicts that are observable in learning to use the pen. Accordingly, if my view is right, these further subdivisions have no wide bearing on the problem of the teacher, and, so far as children are concerned, are of interest only here and there in analysing the general tendencies of certain individuals. In every case what we really need are tests of ease of learning, not of habits already learnt. I have, therefore, not considered it necessary to supplement what some would regard as uni-manual tests with extensive testing for bi-manual activities. In the main I have contented myself with the methods and observations described above.

Questionnaires and Group-tests.—For group inquiries a questionnaire on the following lines will pick out about 90 per cent. of those with left-handed tendencies. 'Which hand would you use (1) to write, (2) to draw or paint, (3) to throw a ball, (4) to strike with a racket, stick, or bat, (5) to hold a penknife, (6) to cut with a pair of scissors, (7) to carry a cup of water or lift a glass in drinking, (8) to clean your teeth, (9) to wind a clock or watch or musical-box, (10) to reach a book or plate on a high shelf almost out of your reach? Imagine yourself doing these things before you answer; and underline the true reply.' The words 'left,' 'right,' 'either hand,' are printed as alternative answers against each question.

For group-tests in class the simpler of the tests of manual

speed and dexterity can be readily applied. In my own investigations the 'tapping,' 'aiming,' and 'tracing' tests were chiefly employed.[1]

II. *Results*

Degrees of Left-handedness.—When the results of such inquiries and tests are plotted in the form of a distribution-curve, it appears at once that right-handed and left-handed tendencies are entirely a matter of degree. The curve is continuous. It is not, however, a normal or even a uni-modal curve. With tests of coarser activities, involving the larger muscles of the hand and arm, the distribution, it is true, approximates more nearly to a uni-modal and symmetrical type, as if for the larger muscles the original tendency was towards symmetry or ambidexterity; though even here the right-handed, or perhaps I should say the right-armed, tendency seems to prevail. But with tests involving the finer muscles of the hand and fingers a completely or predominantly right-handed type is by far the most frequent; the completely or predominantly left-handed type is not so well marked, but still much commoner than the mixed. Thus the curves suggest that the total population is made up of two widely varying and slightly overlapping groups, and that the individuals in the smaller or left-handed group vary far more widely (as, indeed, is common in abnormal groups) than do the individuals in the larger or right-handed group. What is noteworthy, however, is that those children whose two hands are of nearly equal dexterity as judged by the tests, nevertheless tend ultimately to acquire fairly definite preferences or habits. Extremely few use either hand indiscriminately for one and the same skilled action; and comparatively few use different hands even for different skilled actions.

The double peak in the curve is less evident among younger children than among older: hence it is not easy to say with absolute assurance whether the increasing opposition between the two groups is due to some innate difference in

[1] A questionnaire and a series of such tests, specially devised for discovering left-handedness, together with the results obtained by their use, have recently been described by Durost, *loc. cit. sup.*

aptitude that exercises a slow but cumulative influence, or whether (as would seem more probable) it really arises from an increasing self-consistency which in turn may be attributed largely to habit. The point of division between the two curves falls roughly at zero, *i.e.* where L = R and the child appears ambidextrous, this being in fact by far the rarest condition of all. When quantitative tests have been applied, I have taken this zero-point as marking the line of demarcation between the right-handed and left-handed respectively.

Incidence of Left-handedness in the General School Population.—With this line of demarcation, among the groups I have systematically tested, numbering about 600 children in all, I find that just over 5 per cent. (5·2 per cent. to be exact) appear to be left-handed.

Of the children thus shown to be predominantly left-handed, only four out of five among the boys, and only three out of five among the girls, use the left hand to write or draw in the classroom. Based on a writing test alone, therefore, the percentage of left-handed children would prove much too small, and would seem to dwindle very rapidly with age. With the generous aid of the teachers, I have made a wider survey in a larger number of representative London schools, covering in all over 5,000 boys and girls.[1] Here I obtained the following percentages (Table XIX):

TABLE XIX. INCIDENCE OF LEFT-HANDEDNESS AMONG NORMAL, BACKWARD, AND DEFECTIVE CHILDREN

	Ordinary Elementary Schools.		Special (M.D.) Schools.
	Normal.	Backward.	Defective.
Boys	5·8	9·6	13·5
Girls	3·7	6·0	10·3
Average	4·8	7·8	11·9

If we add the backward to the normal, taking each in due proportion—namely, one to ten—the general percentage of left-handed children tallies closely with my own results

[1] The teachers were requested to make special tests and inquiries for each individual child. The criteria suggested were those noted above (p. 271).

among the smaller groups. It is a fraction lower; but that is only to be expected with somewhat cruder methods. Thus we may conclude that at least 5 per cent. of the ordinary school population may be classed as left-handed.[1]

Among the senior departments, out of several thousand children, only seven were reported as ambidextrous: when subsequently tested, all proved to be definitely (though sometimes only slightly) left- or right-handed. In the infants' departments there were thirty-two instances reported in which the teachers were in doubt: for twelve, when subsequently tested, the formula $\frac{R-L}{R+L}$ gave approximately zero. This confirms my conclusion that ambidexterity is extremely rare; and suggests that, as soon as the child begins to form manual habits, a genuine ambidexterity becomes almost non-existent. Among adults, those who claim to be ambidextrous are, as a rule, congenitally left-handed persons who have subsequently acquired a skill with the right hand equal to that of the left.

Incidence of Left-handedness among the Two Sexes.—There is a marked sex-difference. Of the boys, just under 6 per cent., and of the girls, just under 4 per cent. appear to be left-handed. The figures usually cited from earlier school surveys are based, as a rule, simply on the use of the pen or pencil. Such figures, however, differ enormously from school to school, from area to area, and even from one year

[1] Cf. Table XVIII, also *Mental and Scholastic Tests*, p. 311. Other investigators give figures ranging between 2 and 6 per cent., and averaging about 4 per cent. My higher figure seems attributable to the fact that the teachers and I myself have relied more upon direct tests of natural tendency and less upon mere observation of the child's current habit in writing, drawing, or sewing. Considering the slight divergences in the criteria, the proportion agrees quite well with the figures found by Downey and others in America (*Am. J. Psychol.*, XXXVIII, 1927, p. 323), by Ballard in London (*J. Exp. Ped.*, I, 1912, p. 298 *et seq.*), and by Oates in the Midlands (unpublished investigation). I should add that my percentage (unlike that of some other investigators) includes all cases, whether known to be pathological rather than natural, or not. These latter amounted to approximately 0·3 per cent.: in some of these the left-handedness was manifestly due to injury or deformity in the right hand; in others to a mild paralysis dating from early childhood; and in others again quite possibly to some unverifiable damage or weakness in the nervous system or left hemisphere of the brain.

to another. Thus, in two inquiries into left-handedness with the pen or pencil, I found the following percentages: in 1913, 3·8 per cent. among the boys, 2·1 per cent. among the girls; in 1923, 4·9 per cent. among the boys, and 2·7 per cent. among the girls. It is noteworthy that the figures show a marked increase, particularly among the boys: I can trace no such increase in the results obtained from systematic tests of sheer manual dexterity. In the infants' school, left-handedness is almost twice as common among boys as it is among girls; but the sex-difference tends definitely to diminish during the later years. It may be that the natural age-changes in dexterity, which I shall describe in a moment, affect the two sexes differently. My own results, however, were not sufficiently numerous to establish any such effect; and quite possibly the change in sex-incidence with increasing age is an indirect outcome of school instruction: in an inquiry carried out by teachers, an effect of this sort might naturally appear more prominently. Nevertheless, so far as the data can be trusted, it would certainly seem that boys tend to grow out of, or at any rate to correct, this habit somewhat more readily; doubtless, too, both teachers and parents are less insistent with the girls.

Age-differences.—Most observers are agreed that no clear preference for the use of the right hand or the left is to be discerned until the second half of the first year of life, that is, until about the time that the speech-mechanism begins to ripen and the child starts to babble. While the movements of reaching, grasping, and picking up (apposition of finger and thumb) are themselves developing, any bias towards one hand or the other remains imperceptible. The infant of five months grabs with either hand or with both.

According to the American norms, under the age of 6 months the reaching-response in nearly all babies involves movements of two hands and usually of head and mouth as well. Soon after this date, uni-dextrality is discoverable in a very few. By the age of 9 months one hand is preferred in about 60 per cent. of the cases. With these results my own limited experiments on English children are roughly in accord. So far as my experience goes, during the seventh or eighth month casual observation rarely discovers any right-

handedness or left-handedness in the child's spontaneous movements; but about this period its first manifestations may often be caught with an actual test. If, for example, by the conditions of the experiment the child is forced to make an effort in reaching, then a preference for the right hand may regularly be displayed, though otherwise it would not have come to light. Soon after the ninth month a preference for the right hand, apparently spontaneous, can generally be noticed in most ordinary activities, and may be seen even by those who make no deliberate tests. By the eighteenth month the habit is pretty well established. Further tests will show that its strength steadily increases during the next five or six years—that is, during the pre-school and infant school period.

On left-handed children, my notes, though necessarily far more scanty, point in most cases to similar conclusions. They are quite in keeping with the general view that, in a majority of instances, though certainly not in all, left-handedness seems to develop spontaneously. There are many notable exceptions; but these we may return to examine later.

One point, however, has hitherto received inadequate attention. Tests on groups to determine norms, and on individuals to determine the dominant tendency of a given child, are too frequently carried out on a single occasion only. If the test is repeated at intervals throughout the period during which a predilection is emerging, it will often be found that one hand is chiefly preferred on one occasion and the opposite hand on another. As a rule, the same hand is preferred throughout the same day and even throughout a period of two or three weeks; but in many, before the preference is finally fixed, it seems to pass through a stage of preliminary vacillation. During this phase, therefore, it is possible that accident or training may clinch the eventual choice. In an experiment made at my suggestion in training two babies of 9 months, it proved quite easy to set up a left-handed habit, and later to substitute a right-handed habit, by simply keeping objects to be grasped first to the left side and then to the right side of the child. Further studies on early experimental training,

however, are sorely needed. Existing information leaves it uncertain how far the increasing right-handedness of most little one-year-olds is really due to the encouragement or the habits of their mothers and how far it has been left to natural development or to sheer chance.

In tests with children of school age my experiments reveal several instructive variations with increasing years. The general result is that, at any rate up to adolescence, any approach to ambidexterity becomes (as our rough surveys have already suggested) more and more rare. Ambidexterity, however, is not altogether an unequivocal term. Does the alleged equality between the two hands relate to skill alone—to dexterity in the literal sense ? Or are we also to watch for equality in speed and even in strength ?

In strength the difference between the two hands is never so great as in speed or skill[1]; and a good many of the reported instances of so-called ambidexterity prove to be based on tests or observations directed more to the question of strength than to the question of skill. But even in strength a growing divergence is discernible. With right-handed children the superior strength of the right hand increases, though slowly, throughout the school period, and becomes most marked towards puberty. It is then, on an average, about 10 per cent. stronger than the left. The difference is comparatively small : and its smallness is due, not merely to the fact that the strength of the right hand does not increase so definitely as its dexterity or skill, but also to the fact that many individuals whose right hands are more dexterous nevertheless show slightly greater strength with the left.

With tests of the finer forms of skill, on the other hand, the difference between the two hands increases far more rapidly during the school period, though it seems to diminish a little after adolescence has been reached. At 8, the right hand is superior by about 21 per cent. ; at 14, by nearly 30 per cent. ; in adults, by about 25 per cent. With tests of coarser forms of manual skill and of speed the superiority of the preferred hand is also less marked in adults, and even in older boys and girls, than it is during earlier

[1] See the results of the motor tests described above, pp. 262–7.

childhood. At 8, it is 22 per cent. quicker; at 14, 16 per cent.; in adults, 13 per cent. We may perhaps infer that tests involving little skill for older persons may nevertheless be tasks of some difficulty for younger children.

These general conclusions are not without a theoretical bearing. Much of the change that occurs with age can no doubt be explained by practice. But if this were the sole factor, and if the superiority of one hand over the other were due exclusively to habit, we should expect that ambidexterity would be far commoner, and that work with the inferior hand would be far easier, among the very young. This is hardly borne out by the facts. But evidently, in view of the intricacy of the various processes, much more intensive inquiries are needed. Hitherto the influence both of age and of practice has received but little systematic study; yet from the standpoint of practical treatment the problem is of urgent importance.[1]

Association between Left-handedness and Intellectual Disabilities.—The table above (Table XIX, p. 281) shows the incidence of left-handedness among the backward and mentally deficient by comparison with children of normal intelligence. Among the backward it occurs half as often again, and more than twice as often among the mentally deficient. The figures in the table may be summed up in the form of a co-efficient showing the correlation between left-handedness and lack of intelligence. When the whole group is divided into normal children and backward, the coefficient is ·14; and when it is divided into ordinary children and defective, the coefficient is ·19.[2] One further point of practical significance is disclosed by the tests applied to the backward and the defective groups: quite apart from definite left-handedness, the superiority of the right hand tends to be far less marked in the mentally defective than in the dull, and in the dull than in the normal and bright.

[1] The available evidence on the variation of handedness with increasing age is summarized by H. E. Jones, 'Dextrality as a Function of Age,' *J. Exp. Psych.*, XIV, 1931, pp. 125 *et seq.*

[2] As before, I have used Pearson's formula for calculating the tetrachoric correlations. With the large numbers tested the probable error is well under ± ·01.

The connexion between left-handedness and inferior intelligence, as ordinary observation would indeed suggest, is by no means close or regular. Among bright and imaginative children of an emotional disposition, left-handedness is far from rare; and biographers report many eminent persons, of high ability and unquestioned skill, as having been left-handed. Perhaps, however, the famous artists and craftsmen to whom left-handedness is ascribed—Michael Angelo, Leonardo da Vinci, and Sebastian del Piombo, for example—were, like many brilliant operative surgeons of the present day, virtually ambidextrous. On the other hand, many of the dull and backward who pass for left-handed might truthfully be designated ambi-sinistral; they seem not so much dexterous with the left hand as *gauche* with the right.

Association between Left-handedness and Temperamental Disabilities.—Not infrequently the left-handed child shows widespread difficulties in almost every form of finer muscular co-ordination. This is particularly characteristic of those I have just dubbed ambi-sinistral: they squint, they stammer, they shuffle and shamble, they flounder about like seals out of water. Awkward in the house, and clumsy in their games, they are fumblers and bunglers at whatever they do; and it is evident that their general disability is as much nervous or temperamental as it is intellectual.

In many of the cases, quite apart from the guidance of specific skilled movements, nervous control and nervous balance are conspicuously poor in all directions: tics, habit-spasms, odd, incorrigible mannerisms, minor obsessions of every type, are continually observed or reported. Indeed, if it is ever safe to treat left-handedness as a sign or symptom, it should be regarded rather as a mark of an ill-organized nervous system than of a dull or a deficient mind. Among those who are temperamentally neurotic, whether their intelligence be normal, supernormal, or defective, the condition is demonstrably more prevalent. A rough estimate for temperamental instability in the cases here described yields a correlation with left-handedness of nearly ·4, more than double the correlation of left-handedness and intellectual retardation.

Association between Left-handedness and Speech Defects.—Of all the neuro-muscular disorders that characterize the left-handed as a class, by far the commonest is their liability to disturbances of speech—in particular to stuttering or stammering. This is perhaps the most noteworthy difference between the left-handed and the right-handed as a whole. Again and again it has aroused the attention and called forth the warnings of previous observers. To obtain exact evidence on the matter I have made a careful analysis of my records. Among all the right-handed children examined by me, only 1·7 per cent. showed any tendency to stammer. Among the left-handed, 6·5 per cent.—nearly four times as many—showed an impediment at the time of examination; and 11·9 per cent. were reported as having stammered or stuttered in the past, as against 3·2 per cent. of the right-handed.

The detailed notes on my cases indicate that most frequently neurotic troubles, and particularly speech-defects, are found, not in those who are consistently left-handed in all their actions and left-sided with all their limbs, but in those of the so-called mixed type, that is to say, in those who are left-handed for some tasks and right-handed for others, and especially, so it would seem, in those whose dominant eye or foot is on the opposite side to the dominant hand. Among those I have systematically tested, stammering is nearly twice as frequent among left-handers who are right-eyed (8·4 per cent.) as among left-handers who are also left-eyed (4·3 per cent.). This inconsistency may be either a cause of nervous conflicts or a symptom of badly-integrated nervous tendencies. In either case it suggests some underlying lack of nervous balance and stability that reduces the capacity for easy and efficient neuro-muscular co-ordination. Such children seem to have a special difficulty in kinæsthetic control, which shows itself wherever the finer muscles are involved—in the co-ordinated movements of the eyes and of the vocal organs, as well as of the fingers and hands. Strabismus and heterophoria,[1] for example, are particularly notice-

[1] Strabismus or squinting is an actual or manifest lack of parallelism in the movements of the two eyes; heterophoria is a latent tendency towards such lack of parallelism. (See above, p. 226.)

able in such cases. As we shall presently discover, the stuttering is very apt to appear when injudicious methods are employed to train the temperamental left-hander to write with the right hand: and in these instances a temporary squint occasionally supervenes at the same time.[1] It is, too, the child who displays these various inconsistencies in the use of hands and eyes who is most likely to be backward in his work—though not necessarily dull: the child who is, so to speak, unilateralized throughout, whether for the right side or the left, seems to hold his own in the various subjects of his school curriculum far better than the child of a 'mixed' or inconsistent type. When, therefore, we come to practical treatment, it will be essential to consider the type of sinistrality as well as the attendant symptoms.

III. *Explanatory Theories*

The Alleged Increase and its Apparent Causes.—In London, during the past ten or fifteen years, many headmasters and headmistresses have become perturbed over what they take to be an alarming increase in left-handedness among their older pupils. 'This year,' writes one head teacher, 'more than twenty of the boys in my department are left-handed.' And he goes on to echo the common view that the high proportion which he finds may be, in some way or another, an after-effect of the war, attributable perhaps to a nervous shock suffered by the child or by his mother during an air-raid.

In reply it may be remarked, first, that there is not a particle of evidence to support the popular notion that nervous shock or strain during babyhood may of itself be a direct or essential cause; and, secondly, that twenty left-handed pupils in a department of four hundred would, in point of fact, constitute about the normal proportion. What appears to be happening is this. In the more advanced of our modern infants' schools, greater freedom is nowadays allowed for the natural inclinations of each individual child. Influenced in part by the recent theories

[1] For an interesting discussion of the relation of these three functions, see W. S. Inman, 'An Inquiry into the Origin of Squint, Left-handedness, and Stammer' (*Lancet*, 1924, Aug. 2).

that trace stuttering to unwise interference with an innate tendency towards left-handedness, headmistresses no longer compel the young left-hander to write and draw with his right hand. Hence, what strikes the eye of the master in the upper school is an undoubted increase in the number of children now coming up from the infants' department who still use their left hands for ordinary school work: but the increase observed is itself the outcome, not of a sudden spread of constitutional left-handedness, but simply of a change in infant school instruction. This interpretation is borne out by the figures I have already cited[1]: so far as my limited surveys can be trusted, though there has been an undoubted increase in left-handedness as judged solely by the use of the pen, there has been no traceable change when more thorough and more fundamental tests are employed.

What policy, then, should be followed—the older practice which maintained that any child caught holding a pen in his left hand should have his knuckles rapped, or the more tolerant attitude which permits each child to keep to his own peculiar predilection? Clearly, no answer can be given until we know something of the causes of left-handedness. Is it innate or is it acquired? Is it due to some irrepressible bias in the child's inherited constitution, or is it merely an obstinate habit or an accidental trick? Only when we have solved these problems can we say whether a right-hand training for the left-hander is feasible and wise, or whether it will be attended by unsuspected risks and perhaps by insuperable difficulties.

Broadly speaking, the various explanations of left-handedness have followed two lines of approach. The earlier views sought to interpret it by certain physiological or biological hypotheses; the more recent connect it rather with certain idiosyncrasies of temperament. Each, as we shall find, embodies some element of truth.

Differentiation in the Functions of the Hands.—Nature, in giving us two hands, has apparently arranged a division of labour between them. Seldom, either in primitive life or in civilized activities, are both hands occupied in doing precisely the same thing at precisely the same time. Carlyle,

[1] See above, p. 283.

indeed, once declared that 'no organized manual labour could be carried on unless there were a common agreement as to which hand should be used for specialized tasks.' [1] It is not that one hand is alone active, while the other does nothing and reposes idly in the trouser pocket. Each hand has its function: but the functions are complementary. One hand is used for the more lively movements, and the other for steady postures; one for the finer, skilled actions, and the other for the coarser and more mechanical. With most human beings the more delicate tasks are regularly allotted to the right. The left hand grasps the shield, the right hand wields the sword or the spear; the left hand grips the rifle, the right hand pulls the trigger; the left supports the book, the right remains free to turn over the pages; the left steadies the dress material or the writing paper, the right manipulates the needle or the pen. And, generally, whether in striking, cutting, sawing, painting, drawing, playing the violin, or lighting a match, the left hand takes the bulkier portion of the thing to be used, and holds it firm and still, the right hand picks up the smaller object or the more mobile part—the knife, the saw, the brush, the pencil, the bow, or the matchstick—and carries out the active and nicely adapted movements controlled by the fingers or the wrist. Clearly, an innate tendency to work in this way would avoid the hesitation and effort that would otherwise ensue were we completely ambidextrous and obliged to decide afresh on every occasion which of the two hands to employ.

We have seen that in two-handed activities, like batting or sweeping, the usage of the hands may, among certain persons, appear at first sight to be out of keeping with the usage in one-handed activities; and we have noted how many investigators have recently urged that the left-handed and right-handed should be re-classified into sub-types on this further basis. We also saw that the true reason for a divided preference had never been made clear. But if the account I have just put forward is right, and if the course of evolution has led, not to a predominance of one hand, but to a division of labour between the two, then

[1] J. A. Froude, *Thomas Carlyle: A History of his Life*, II, p. 407.

we may regard the difference between 'bi-manual' and 'uni-manual' activities as merely one of degree. And this is confirmed by more accurate observation. In most of the activities described as 'uni-manual'—writing, hammering, eating, and the like—a second hand commonly plays an essential though subsidiary part: it steadies the paper in writing, the nail in hammering, and the meat by means of a fork. Two-handed instruments, on the other hand, like brooms, bats, and spades, are generally weighty; and, whether one hand is needed or two, weighty objects are not manipulated with much address or skill. Consequently, the task of simply supporting them is usually relegated in the main to the unskilled hand. Then, if guidance is required, the more dexterous hand is free to impart it. Thus, as we have already seen, with the ordinary right-handed person, the left hand serves to provide the fulcrum, and hence is placed lower with the spade and higher with the bat, hockey stick, or golf club. But if no special skill is wanted, it matters but little which hand is used or how the labour is divided. Accordingly, tasks such as pushing a light broom, carrying a parcel, or holding up an umbrella, may be executed with either hand indifferently. If, however, there is the least likelihood that skilled finger-movement may presently be needed for some other activity—opening a door, for instance, or picking up change—then the weighty object—the umbrella or the parcel—is kept in the left hand, so that the right is free. In such cases, indeed, it is not so much the left hand that is active as the left arm: the larger muscles are principally involved, and the tiny muscles of the wrist and fingers are engaged in no swift or delicate adjustments. In those individuals, however, in whom the right hand is not only more skilled but also more powerful, the common usage will, as a rule, be reversed, particularly for those two-handed activities where power is more important than adroitness. And generally it will be found that the anomalies in two-handed work to which attention has been called arise from exceptional requirements not merely in dexterity but also in strength.

Such considerations, therefore, confirm my view that these minor differences do not really constitute further

'types of handedness.' They are simply intelligible developments of the two main types. The crucial point to be determined, then, for any given individual, is merely this. Which of the two hands is more trainable for skilled movements and how great is the difference between the two? Whether the individual is consistent in his habits is a subordinate issue. This further question may, indeed, throw light on the degree of difference; more probably it will throw light on his general consistency—a matter of temperamental stability rather than manual skill; but, for the most part, his behaviour in these respects will be the outcome of comparatively irrelevant influences—the strength of the two hands and arms, and the particular conditions under which his two-handed habits have grown up.

Is Left-handedness Hereditary or Inborn?—The first and fundamental problem, therefore, is whether the differences in trainable skill are actually innate. Were left-handedness purely the result of accident or custom, the teacher's task would be both obvious and simple. But were it the result of an inborn proclivity, we should doubt if it was wise to work against it, and we should certainly expect modifications to be harder.

The popular view has always been that left-handedness is inborn. Yet in the past many writers pilloried this notion as a 'vulgar error.' They have maintained that the preference for one hand or the other is learnt afresh by each individual. Sir Thomas Browne, for example, held that the right-handedness of the multitude is nothing but a sane and serviceable convention. 'It is most reasonable,' he writes, 'for uniformity and sundry respective uses that man should apply himself to the constant use of one arm. Dextral pre-eminence has no regular or certain root in nature.'[1]

Scientific investigation leaves the issue still unsettled. Various lines of evidence have been examined. The first and the most obvious consists in an observant study of the growing child during the pre-school stage. In most infants, as we have seen, right-handedness can be detected before the age of twelve months; and the tendency seems

[1] *Vulgar Errors*, IV, 5.

to emerge about the time that the nerve-fibres running from the higher motor centres of the brain towards the muscles acquire their insulating sheaths. First-hand observation strongly suggests that the child's preference for the right hand is a spontaneous preference; but this of itself is hardly conclusive, since, as was noted above, to exclude all external influence is never so simple as is commonly supposed. Hence even the most careful observers do not agree. Watson, for example, is convinced that handedness forms but another instance in which what is hastily mistaken for an instinct is really an artificial habit due to early 'conditioning.' He declares that 'our whole group of results' on the development of young infants 'lead us to believe that . . . handedness is not an instinct, but is socially instilled and conditioned.'[1] Gesell, on the other hand, whose pre-school studies are equally numerous, inclines to the view that sinistrality, though perhaps in itself 'a secondary by-product of a more fundamental family trait,' is, indirectly if not directly, the outcome of 'germinal factors.' He owns, however, that the testimony from such sources has proved, so far at any rate, somewhat inconclusive.[2]

A more cogent argument might be drawn from the universality of the right-handed tendency. In every country and in every race, primitive as well as civilized, right-handed persons far outnumber the rest. If the preference rested merely on social convention, we should expect it to vary from one community to another, like the rule of the road. Now it is stated that in the right-handed the bones of the right arm are longer and stronger, and the bones of the left in the left-handed, and that a corresponding asymmetry is discernible in the skull.[3] Actual measurements would appear to show that the right arm is longer in 75 per cent. of the population and the left in 9 per cent.[4] Of course, addi-

[1] *Ped. Sem.*, XXXII, 1925, p. 322. [2] *Infancy and Human Growth* (1928).

[3] Elliot Smith, 'Right- and Left-Handedness in Primitive Men,' *Brit. Med. Journ.*, II, 1925, pp. 1107–8.

[4] Schaeffer, 'Spiral Movements in Man,' *Journ. Morph. and Physiol.*, XLV, 1928, pp. 393 *et seq.* Schwerz summarizes bone-measurements in different racial groups ('Die Rechtshandigkeit des Menschen,' *Arch. f. Rassen und Gesellschaftbiologie*, XI, 1914, pp. 299 *et seq.*). Among children during lifetime, structural measurements have proved to be of little use

tional use might conceivably lengthen and strengthen the preferred arm, since at birth the length is said to be almost identical. But it is singular that much the same proportions apparently hold good, not only among living races of to-day, but at least as far back as the early bronze age. Indeed, by examining the interior of ancient skulls Professor Elliot Smith claims to have demonstrated that the earliest known Londoner and the earliest known ape-man (Pithecanthropus) were both right-handed: and his inferences seem partly corroborated by cave-drawings of the Madeleine (late palæolithic) type and by the stencilled left hands in caves of the earlier Aurignacian period. Judged by implements, however, right-handedness was still far from general during the stone age. The semi-erect apes show a slight preference for using the right hand [1]; and, going farther down the scale, a preference for using the right fore-limb is said to be somewhat commoner in normal rats than a preference for using the left or a complete indifference, while a preference for the left appears to be relatively more frequent in dull and backward rats who have been deprived of vitamins.[2] These sporadic observations are not very widely confirmed. But, so far as the available evidence goes, it would certainly seem that a tendency towards right-handedness has been passed down from prehistoric if not prehuman times, and that it first became well marked and widely prevalent during the early tool-using epoch when the hand gradually evolved its characteristically human flexibility and skill.[3]

to determine handedness; and a special difficulty even with adults is that the differences between the two sets of arm-bones are not always consistent: the right humerus is in most persons longer than the left, but at the same time the right ulna and radius are not infrequently the shorter.

[1] See Köhler, *Mentality of Apes*, pp. 32–3, 36, and W. N. and L. A. Kellogg, *The Ape and the Child*, pp. 54 *et seq.* But a 'preference' is not the same thing as a readier capacity for skill.

[2] Tsai and Mauer, 'Right-handedness in White Rats,' *Science*, LXXII, 1930, pp. 436–8. Most horses gallop with the right foot leading; other quadrupeds, so it is declared, show similar tendencies when averages are taken.

[3] Cf. P. Sarasin, 'Rechtshändigkeit in der Prähistorie,' *Naturforsch. Gesellsch. in Basel Verhandl.*, XXIX, pp. 122 *et seq.* The earliest written record that I know of gives the proportion of left-handers as 2·6 per cent. (men of Benjamin, Judges xx. 15, 16).

There is, however, a step in the argument which is all too frequently overlooked—a step that is particularly relevant here. It is, as a rule, taken tacitly for granted that the causes of right-handedness and left-handedness are necessarily analogous, so that, when right-handedness has been proved innate, it has been assumed as a corollary that left-handedness must be innate as well. This does not follow. Left-handedness might be due (as in certain individual instances it undoubtedly is due) to some interfering factor. But since right-handedness is twenty times as common as left-handedness, direct observations on the emergence of the latter are twenty times as hard to procure.

But a third line of inquiry may be attempted, which would be still more convincing were it successful. It is claimed that left-handedness, where it exists, tends usually to run in families. Accordingly, it is tempting to ascribe the family resemblance to heredity. Moreover, the proportions of left-handed persons are small but comparatively constant; and this has naturally prompted the view that left-handedness might be inherited as a Mendelian recessive.[1] Let us glance briefly at the facts so far as they have been ascertained.

In this direction the most ambitious inquiry is that of Chamberlain. A population of over 12,000 was surveyed. It was found that, in families where one or both parents were left-handed, 17 per cent. of the children were left-handed also; in families where both were right-handed, only 2 per cent. of the children were left-handed. Chamberlain concludes that 'there can be no doubt the trait is inherited, but not as a Mendelian recessive.'[2] Unfortunately his material was collected mainly by questionnaire, and writing was used as the sole criterion.

In the cases of left-handedness for which I myself have accumulated data, 14 per cent. had a left-handed parent, and in 31 per cent. there were left-handed persons among the remoter relatives. In one family I found seven, and

[1] This seems first to have been suggested by Ramaley, 'Inheritance of Left-handedness,' *Amer. Naturalist*, XLVII, 1913, pp. 730–8.

[2] 'The Inheritance of Left-handedness,' *Journ. of Heredity*, XIX, 1929, pp. 557–9.

in another five instances of left-handedness. A French investigator, Aimé Père, reports a family in which he traced as many as twenty-five.

Of the left-handed children in my backward and control groups, five had twin brothers or sisters. Of these twins two were 'non-identical' and right-handed; three were apparently 'identical,' and of these again two were left-handed and one was not. In a separate inquiry upon the mental characteristics of twins, I found, in a group of eighty-four, four instances where both twins were left-handed (these were apparently 'identical' twins), and only a single instance where one twin alone was left-handed (these twins were manifestly not 'identical'). With the identical twins, it might perhaps be argued that sympathy or similar instruction could have produced the similar habits; yet this seems scarcely tenable, for in three instances one or both had been trained almost from infancy to use the right hand, and the left-handedness was only revealed by careful inquiry and testing. Other investigators likewise find that 'a great majority of the unequivocal cases of identical twins exhibit a same-sided asymmetry'; still, it seems equally certain that a few do not, and so the genesis of left-handedness proves far more complex than might at first sight be expected.[1]

Can these facts be explained without invoking heredity in some form or other? It is a commonplace, in discussing psychological transmission, to insist that a resemblance

[1] H. H. Newman, 'Mental and Physical Traits of Identical Twins Reared Apart,' *Journ. of Heredity*, XX, 1920, pp. 49, 97, 153, *et seq.* From his studies Newman concludes that left-handedness is inherited as a Mendelian recessive, but that occasionally epigenetic development (*i.e.* the differentiation resulting from environmental influences and the interaction of the parts of the developing embryo with each other) may result in discrepancies between one twin and the other ('Studies of Human Twins,' *Biol. Bull.*, LV, 1928, pp. 298–315). It may be remarked that similarity of finger-prints and hand-prints has been put forward as one method of distinguishing 'identical twins' and that some observers claim to have noted significant differences in the finger-prints of the left-handed both in left-handed twins and in left-handers generally. Newman's hypothesis is criticized by Reichle ('Diagnosis of Monovular Twinning,' *Ibid.*, LVI, 1929, pp. 313 *et seq.*). Cf. also Wilson and Jones, 'Left-handedness in Twins,' *Genetics*, XVII, 1932, pp. 560 *et seq.*

between parents and offspring does not of itself provide proof of inheritance. Unlike physical characteristics, mental characteristics may owe their resemblance to imitation. At the moment psychologists are far more chary of admitting heredity as an explanatory principle than they were twenty or thirty years ago. Thus, it is contended, the left-handed child may have simply copied his parent's left-handedness; and the behaviourist, as we have seen, ascribes left-handed and right-handed habits to what he calls 'conditioning,' that is, to learning by slow association.

Now there can be no question that right-handed and left-handed habits can at times be formed in this way. We have seen how the left-handed youngster may, when he comes to play in a cricket team, adopt a right-handed method of holding the bat. I have several examples where right-handed pupils (all of them girls) copied left-handed methods from a left-handed teacher. But to explain every case along these lines would hardly be possible. In orphanages I have found many instances of left-handed children who had been taken from their left-handed parents during their earliest months. In other families the left-handed relatives are not the parents at all, but grandparents, uncles, aunts, or cousins, whom the child has rarely seen. Finally, it is quite easy in these days to discover young people who have come to write or sew with the left hand, without ever knowing that their father or mother was left-handed. The parent, brought up in an austerer age when conventions were more sternly imposed, has adopted right-handed methods during childhood; and, not until a searching inquiry has been made, is it remembered that he was left-handed in his earlier years.

Imitation, therefore, may account for some instances: it cannot account for all. We must look for some other mode of regular transmission.

Here reflection suggests one obvious factor influencing a child long before he is likely to imitate, in any true sense of the word. It is a factor which operates just about the time that most children develop a preference for one hand rather than the other—namely, the mode by which the mother carries the child when he is old enough to sit up in her arms.

Every mother, it might be supposed, would regularly use her stronger hand to support her baby. Hence, if she is right-handed she will naturally hold him on her right side. The child will accordingly put his left arm round her neck, and so have his right hand outward, and free for active movement. Conversely, if the left-handed mother holds her baby on the opposite side, the child will use not his right but his left hand to pick up his toys or to wave 'Good-bye.'

Now the right-handed method of holding the baby seems certainly looked upon as orthodox: it is taught in several institutions where nurses are trained, and occasionally in classes where younger girls are instructed in infant management. Further, a great many left-handed mothers undoubtedly assume the opposite position. Nor is it difficult to find instances where the mother's attitude has apparently affected the movements of the child. I have three well-authenticated cases where the mother, from injury or other reason, altered her habitual posture; and the child in consequence changed from right-handed to left-handed habits—though, it must be admitted, the new habit did not become permanent.

Nevertheless, to attribute every instance of apparent transmission to this unconscious influence would be to fly in the face of the facts. First of all, among the working classes it is by no means unusual for the right-handed mother to carry her child about on her left arm, so as to keep her own right hand free for work. On making a peripatetic census in the streets of poorer districts, where mothers take their infants with them when they shop, I found that in seventy-three cases the child was carried on the left arm and in only twenty-seven on the right. I have also examined a hundred well-known pictures of the Madonna and Child, and find that fifty-nine have the child on the left and only forty-one on the right: with the earlier painters, in particular, the left position seems commoner.

Secondly, the assumption that because the left hand is unskilled it must therefore be weak is, as we have seen, not altogether justified. On the contrary, the left hand is very generally used for carrying heavy objects. Wider observation will show that, even where a mother clasps her child

against her right shoulder, she often uses her left hand to support him, leaving to the right hand, as the more delicate and more agile member, the task of supplying any additional adjustment or aid. Glance again at the best-known Madonnas of all—the Sistine and the Madonna del Granduca: in the one the child is on the mother's right, in the other on her left; yet in both Raphael has placed the left hand beneath the child to bear his main weight.

Thirdly, my own records include at least a score of cases where a right-handed mother has habitually carried the child on her left arm, and the child nevertheless has in the end become right-handed, as if his own right-handedness rested on an inherited tendency that reappeared and slowly ripened,[1] irrespective of the freer opportunity for exercise thus afforded to the left. I have half a dozen more where the child of a left-handed mother was never carried by the mother at all, but by a right-handed nurse who adopted the orthodox right-handed method, and still the child developed a left-handed habit. And I could cite another dozen, where a left-handed mother with a family of several children adopted the same method for every one, and yet some turned out right-handed and others left-handed. Finally, the explanation proposed must plainly break down altogether in the instances where, not the mother, but the father is the left-handed parent of the left-handed child. Indeed, in accordance with the usual sex-difference, among the various families whose pedigrees I have traced, the left-handed relatives were far more often male than female. What is more, the proportion of male and female left-handers proves to be singularly constant; and this of itself is suggestive of some specific law or principle. Left-handedness, we have seen, occurs nearly twice as often among boys as among girls; and a similar ratio holds good among adults, when careful tests or inquiries are made, and has, in fact, been noted by almost all observers. Such points as these raise a strong presumption that left-handedness depends on much the same conditions as sex—namely, on innate constitution.

[1] Woolley ('Development of Right-handedness in the Normal Infant,' *Psych. Rev.*, XVII, 1910, pp. 17–41) records an instance of this kind in a child she kept under experimental observation.

I find it, therefore, quite incredible that the various facts I have summarized can be interpreted in terms of habit-formation only, without invoking the influence of some innate and inheritable factor as well. This general conclusion is borne out by prolonged observation of young children under scrupulously controlled conditions. When every effort is made to prevent the child being affected by conscious or unconscious influences, a preferential tendency seems in the majority of cases to develop at much the same age, and to develop fully, freely, and spontaneously.

Still, when all is said, the very need for these circuitous arguments has its own significance—a significance which bears directly on the practical problems of the teacher. It implies, first, that the inherited bias must in most instances be comparatively slight, otherwise it would not be so difficult to substantiate; and, secondly, that there must be numerous instances, more or less exceptional, which cannot be explained by heredity at all. With any individual child, therefore, other factors must be cautiously ruled out before any innate tendency can be safely presumed.

Cases apparently Congenital: Sub-types.—Among what are usually regarded as congenital cases, two distinct groups or sub-types seem discernible. I am tempted to call them anatomical and temperamental respectively. In the former the left-handedness seems to rest primarily on a structural basis; in the latter it seems to arise—to borrow a term from the neurologist—rather as a functional symptom. In both, so far as the evidence goes, the left-handedness appears spontaneously in the individual, and is traceable in several members of the family: but in the former the peculiarities accompanying it may be most easily described in bodily terms; in the latter they may be described in psychological.

In the anatomical type (if I may use so loose an expression) the dexterity of the left hand appears as one special instance of a general transference of muscular dexterity from the right side of the body to the left. In these cases the superiority of the left hand in nearly every test is definite and outstanding. Further, the left-sided preference often extends to other members of the body—to the left eye and to the left leg.

These are the cases that fit best with the explanation which, as we shall see in a moment, has been mainly put forward by anatomists and physiologists, namely, that, just as in some persons the heart may be found on the right side of the body, and the liver on the left, so in others there is an inborn transposition of structural delicacy and functional superiority from the left hemisphere of the brain to the right hemisphere and from the right side of the body to the left.

In all such cases the marked feature is the co-existence of other reversals. A left-handed child of this type usually hops and kicks with his left foot and uses his left eye for predominant fixation.[1] Of the left-handed cases tested by me, 82 per cent. were left-footed ; of the right-handed, 94 per cent. were right-footed (the exceptions being often explicable by injury or deformity). Of the left-handed cases, 61 per cent. were left-eyed (57 per cent. among the boys and 65 per cent. among the girls) ; of the right-handed,

[1] The use of the foot is not always consistent. The more important tests or questions are—with which foot does the child (1) first step off, (2) first step up, (3) first step down, (4) kick, (5) hop, (6) press (as in digging with a spade or stamping on a ball of paper), (7) spring off (as in jumping), (8) tap most rapidly. In marching the regular instruction is to step off with the left foot first ; and actual measurements on adults indicate that the bones of the left leg are usually longer. Once again the whole inquiry turns out to be unexpectedly complex.

For testing the relative dominance of the two eyes, the following method is the simplest. Stand about 10 yards from the child, and tell him to hold up a finger or a ring in front of your nose. It will then be found that nearly all the right-handed children, but less than half the left-handed, bring the ring or finger before their own right eye, thus neglecting the image seen with their left. For tiny children it is better to give the child a card with a hole in it, and require him to look at a second card showing three objects—say, a green leaf, a silver star, and a red cherry—placed at intervals of 5 inches. He is to hold the card so that he sees nothing but the star through the hole. The test should be repeated both with the right hand and with the left, since occasionally a child may tend at first to put the ring or hole in front of the eye nearest to the hand employed—the left eye if he uses the left hand, the right eye if he uses the right. It is perhaps a neglect of this precaution that accounts for the high correspondences reported by one or two investigators. With adults the use of the right eye or the left for the telescope, for the microscope, or for the sighting apparatus of a gun, depends on many different influences, and is not a reliable criterion : a special test is always needful.

73 per cent. were right-eyed (70 per cent. among the boys and 77 per cent. among the girls). The correlations are—for correspondence between hand and foot ·86, and between hand and eye ·77.[1] Similar reversals are often found in the relatives ; but it is difficult to investigate relatives as well as children with the completeness that a statistical comparison would require. Rough as they are, however, the figures suggest that this type is by far the more numerous of the two.

In the temperamental cases the child rarely shows reversals extending to other parts of the body, and often he is left-handed for certain actions only : significantly enough, these are, as a rule, the very actions in which the opposite usage—namely, the right-handed—is most rigorously enjoined by social convention. Often other neurotic or temperamental peculiarities are reported both in the child and in his relatives ; and, although among the relatives left-handedness is itself also reported (otherwise the condition would hardly get described as congenital), it is not found with any great frequency.

Strictly speaking, of course, the left-handedness as such is here no more congenital than insanity or tuberculosis is congenital. At most it can be only an indirect consequence of some deeper underlying tendency. What seems to be inherited is, as it were, a peculiar disposition or temperamental diathesis in virtue of which, under certain social conditions, left-handedness is particularly apt to appear as a quasi-neurotic reaction. But were I pressed, I should in the last resort contend that probably all forms of left-

[1] The coefficients are the tetrachoric correlations calculated by the method described in Appendix III. This method assumes that both of the characteristics to be correlated—intelligence and the strength of the tendency to use the left hand, etc.—are distributed by continuous variation and more or less in accordance with the normal curve. Left-handedness, however, as we have already seen, does not appear to be distributed normally. Nevertheless, it is not to be regarded as a completely discontinuous trait, sharply marked off from right-handedness. Both are found with varying degrees of strength. Hence, for purposes of a rough calculation, the method seems permissible. The correlation between eye and hand apparently diminishes with age : among the older children, and again among students, I find less than half of the left-handers left-eyed : but the groups are too small to allow any certain conclusion to be drawn.

handedness are only indirectly hereditary: post-natal influence seems always to enter in. Hence at bottom the difference is largely one of degree.

I must accordingly repeat that, here as elsewhere in psychology, our present knowledge is far too meagre to allow us to declare with any assurance what is inborn and what is not. The distinction is drawn only with a view to its practical corollaries. In the one case the condition can hardly be prevented and very seldom changed: in the other, suitable precautions may be expected to preclude its formation, and, when formed, the condition may be hopefully treated or restrained.

The moral is plain. In no case should the left-handedness be regarded as a limited or isolated symptom. It must be considered in the light of other associated characteristics. The teacher, therefore, should always note whether the child's preference for the left extends to other physical actions or is restricted only to the hand, and whether it affects all the finer movements of the hands or only some; and further how far, if at all, it seems to be constitutional—part of a general one-sided organization, and how far it is a semi-neurotic reaction or perhaps even a merely accidental or obstinate habit.

Cases apparently Acquired.—That left-handedness is in some instances nothing but an acquired habit appears unquestionable. I have several cases where the child was left-handed for certain old and long-established movements—for writing, for sewing, or for the use of the knife and fork, while in nearly all the psychological tests he showed unmistakably that his right hand was superior in dexterity. In a few, the emergence or fixation of a natural right-handed tendency had apparently been prevented or postponed by injury to the right hand itself during the critical period: under such conditions a temporary left-handedness may develop, and at times get permanently established. I also have reports of three cases where both hands were injured during the crucial stage, and the child, presumably for some accidental reason, became in the end left-handed. And, although I believe that, as a general rule, hand-preference is not caused by eye-preference, since eye-preference arises

later, nevertheless I have come across two instances in which left-handedness appeared to develop at a comparatively late stage as a result of a severe but recent weakness in the right eye: one child—a girl of 13 whose right eye had been injured and was covered by a shade—expressly excused herself by saying she found it easier to use the hand on the side on which she could see best.

Whenever it is traceable to accidental factors of these various kinds, the left-handedness of the left-handed child is nearly always far less marked than the right-handedness of the ordinary right-hander: indeed, the results of the dexterity-tests indicate that this statement would hold good, though not in such a marked degree, for nearly all left-handed cases, even where the left-handedness seems to be innate. A few anatomists have even claimed that the acquired types can be distinguished from the congenital by structural measurements: they aver that, in those who have been forced to use the left hand by accident, only the muscles are enlarged, whereas, as we have seen, in those who have been left-handed almost from birth, the bones of the left hand and arm are generally larger. In practice, however, it would be far easier to measure the activities of the limb than its size or shape.

Relative Frequency of Congenital and Non-congenital Types.—Taking into account all the data available for the individual cases that I have been able to subject to systematic study, I find the relative frequency of the various types to be as follows. · Cases in which left-handedness seems predominantly an acquired habit, 17 per cent.; cases in which left-handedness appears predominantly hereditary (left-handedness spontaneous, found usually in several members of the family, and accompanied by other anatomical transpositions), 36 per cent.; cases in which an allied temperamental disposition appears hereditary (left-handedness, accompanied by temperamental symptoms and itself not found in more than one or two members of the family), 9 per cent.; cases in which left-handedness seems to have been predominantly spontaneous, though the information is inadequate for further classification (no recorded instances of left-handedness in the family), 38 per cent.

The answer, therefore, to our original question amounts to this. We may agree that in most human beings—possibly in all—a tendency to use the one hand rather than the other is, in a greater or lesser degree, congenital. Opportunity, exercise, social influence and suggestion, however, are needed to call out this tendency, and ultimately to fix it. Moreover, we have been led to suspect that the initial congenital tendency is by no means so overwhelming as casual observation of adult habits might at first convey, and that its strength varies widely from one person to another. The left-handed tendencies, like the right-handed, often appear not only innate, but also, at any rate in many instances, hereditary, and incline in their inheritance to be sex-limited. Accordingly it remains quite conceivable that the underlying or contributory factor may follow Mendelian laws, and act as a 'recessive'; but it can scarcely be maintained that left-handedness as such—*i.e.* all the manifestations covered by that somewhat inexact phrase—is to be regarded as a Mendelian recessive or even as in itself strictly congenital and innate.[1]

[1] The chief objection to a Mendelian interpretation is that left-handedness, as we have seen, is so largely a matter of degree. (For an examination of this question along statistical lines, see Pearson and Woo, *Biometrika*, XIX, 1927, p. 199.) Nevertheless, as I have already remarked, a closer study of some of the curves of distribution reveals that, underlying the crude data, there are at times indications of two mutually exclusive tendencies. Hence broad statistical surveys, such as that of Chamberlain, can hardly be taken to disprove the possibility of a Mendelian interpretation of certain forms of lateral asymmetry. More intensive studies are wanted. In my own records there are three families in which *both* parents were left-handed. Were the condition a simple recessive, Mendelian principles would require that *all* their children should be left-handed. This happened in none of the families, although every child was thoroughly tested to detect any latent left-handedness. The proportions in fact were fairly equally divided. That, of itself, would seem to dispose of the recessive theory in its simplest form. I would suggest that the principles underlying the inheritance of left-sidedness may possibly be found akin to those that govern hemilateral asymmetry (or, in plain language, lopsidedness) in general. Few men have symmetrical faces or symmetrical finger-prints: where the asymmetry is well-marked—*e.g.* in differently coloured irises or differently shaped ear-lobes—it usually proves to be explicable by a double inheritance from two different parental stocks. With animals when breeds are crossed—four-toed game fowl with five-toed Dorkings, fantail and homer pigeons, cattle with

Causes of Right-handedness.—We can, however, hardly hope to understand why the few are left-handed unless we know why the majority are right-handed. This brings us to a far more puzzling problem. Assuming that hand-preferences are partly inherited and partly acquired, why is it that the right hand is so generally favoured ? Could we discover a reason or a cause, the teacher's task would be clearer : for he would then know how much was to be gained or risked by training the left-hander in right-handed habits.

A survey of the literature shows that most theorists have sought a physiological rather than a social explanation, and have principally inclined towards one or other of three conceivable causes : they have sought to derive the asymmetry of the hands from some prior asymmetry in the eyes, or in the brain, or in the viscera.

(1) Since all movement is initiated by sensation, it is natural to suspect that any widespread difference in movement may arise from some corresponding difference in sensitivity. In human beings, after the first few months of life, nearly every movement of the limbs that is neither reflex nor instinctive is made in response to visual stimuli : and, in particular, nearly every movement of the hands is, not only started by the eye, but also controlled by the eye.

Now, as we have already observed, most people are right-eyed as well as right-handed. They look at things rather with the right eye than with the left ; and when they wink, they close the left eyelid. Further, the preference for the left eye, though rarer in itself, proves to be much commoner among the left-handed than the right-handed. That has been demonstrated by the figures already adduced. Do not these simple facts disclose a possible reason for right-handedness and left-handedness respectively ?

upward and downward curving horns—asymmetrical offspring frequently result. In breeding pheasants, birds occasionally appear which on one side are coloured like a male, with a spur on the foot, and on the other coloured like a female, with no spur : such asymmetry is again usually traceable to hybridization. In human beings the differences are less well defined, and speculations about their origin still more precarious. But certainly, in one important respect, we are all of hybrid descent, for each of us is the offspring of a male and a female, both of whom may carry different characteristics.

The dominance of the eye in its turn (so at least it is natural to suggest) could readily be explained by its superior visual acuity. Galton, for example, supposed that by choice we all rely mainly on the 'stronger,' that is, on the sharper eye. The inference can be checked by answering a further question: Is there any evidence that the acuter eye is generally the right?

In my own visual tests both of children and of adults I certainly find that visual defects are commoner in the left eye, particularly among the males. This is further borne out by the figures published in school medical officers' reports.[1] It is noteworthy, too, that the tendency to use the right eye for fixation is stronger in the males: and I have already mentioned two instances in which a child, whose right eye had been injured or weakened, had, apparently as a consequence, become in part left-handed.

Unfortunately for the argument, however, when the observations are made on groups large enough to yield fairly trustworthy proportions, the figures actually found for acuity are far from analogous to the figures for right- and left-handedness. Judged by visual acuity, the right-eyed should amount to only 56 per cent. of the population, whereas the right-handed amount to 95 per cent. It is true that, among the left-handed, visual defects in the left eye are less common than in the right; but the difference seems much too slight to indicate a causal factor operating upon a widespread scale. Moreover, systematic inquiry into individual cases shows that there is really very little correspondence between visual acuity and eye-preference when we consider particular persons.[2] Finally, the three differences themselves usually develop in the opposite order from that which the theory demands—the difference in sighting tendencies develops *after* the difference in the use of the

[1] For example, those quoted in the *Board of Education Reports* (*e.g.* Report for 1911, p. 38, and subsequent issues).

[2] Woo and Pearson made a statistical examination of Galton's data (collected chiefly among older persons) and similarly found no correlation between right- or left-handedness and visual acuity on the preferred side (*loc. cit. sup.*).

hands, and the inequality of vision, as a rule, develops last of all.[1]

It might, however, be contended that these crude tests of visual acuity discover only the coarser defects due to errors of refraction, which in most instances appear relatively late in childhood and even change their nature during the period of growth. The determining difference, therefore, should perhaps be sought, not in any difference due to defects in the lenses (which alone are looked for in the ordinary ophthalmological tests), but rather in differences in the acuity of the retinæ themselves—differences that would still persist after proper spectacles had been provided or when no spectacles were required.[2] Two investigators go further still. They assert that the fundamental difference appertains, not to one eye rather than the other, but to one side of each eye. Most of us see things (so at least their experiments convey) more distinctly on the right side of the field of vision than on the left. In infancy, they declare, objects on the right-hand side must actually look larger and more conspicuous, and so attract movements of the right hand.[3]

But here the argument begins to stray into very nebulous regions. All the differences reported are extremely difficult to verify and, as a rule, comparatively trifling—so trifling, indeed, that it is doubtful whether they could possibly affect the use of the two hands. In any case, we should still have

[1] The view that right- and left-handedness are the result of eye-preferences has been argued most trenchantly by B. S. Parsons (*Left-handedness: A New Interpretation*, 1924). Parsons also believes that left-handedness is inherited, probably as a Mendelian recessive ; but apparently his meaning is that the dominance of the hand is due to a dominance of the eye and this in turn to a dominance of the cerebral hemisphere—that being the real inherited factor.

[2] One observer, for example, J. van Biervliet (' L'asymétrie sensorielle,' *Bull. Acad. Roy. Sci.*, XXXIV, iii, 1897, pp. 326–66), finds that, on an average, the visual acuity of the favoured eye excels that of the unfavoured by about 12 per cent., even when defects of refraction are corrected.

[3] H. C. Stevens and C. J. Ducasse, ' The Retina and Right-handedness,' *Psych. Rev.*, XIX, 1912, pp. 1 *et seq*. The non-physiological reader should note that objects seen on the right-hand side of the visual field are focused on the left of each retina, and that the nerve-fibres from the left half of each retina run exclusively to the left hemisphere of the brain, although those from the spot of clearest vision—the centre of the retina—run to both hemispheres.

to ask: why should the right eye, or the right half of the field of vision, be better developed in nearly all human beings? It is tempting to retort: because nearly all human beings are right-handed, and so more practised in looking towards the right. The influence of hand-preference on eye-preference must be at least as great as that of eye-preference on hand-preference.

(2) A more widespread view ascribes the superiority of the right hand (and possibly of the right field of vision) to an innate superiority of the left hemisphere of the brain, which, as every student of physiology is aware, is connected with the right side of the body. It is said that the left half of the brain is in most persons heavier than the right by about one-eighth of an ounce[1]: certainly, the surface of the left hemisphere appears generally to be the more extensive[2]; and, since the motor areas lie in the cortex or rind, it is surface rather than bulk that counts. Hence, it is argued, the muscular activities controlled by the left hemisphere will attain the highest degree of skill; and this, it is supposed, applies not only to those of the legs and arms and hands, but also to those of speech. Of all our muscular activities those involved in speech are the most delicate and the most elaborate; and, though so-called speech-centres are found on both sides of the brain, the speech-centre in the left hemisphere is alone said to be active in right-handed persons, while in the left-handed it is the speech-centre in the right hemisphere that appears chiefly to function. Certainly, in the rare cases where post-mortem examination of aphasic patients reveals a damaged speech-centre on the right side of the brain instead of on the left, there it has often been reported that the patient was left-handed.

None of these statements rests on very secure grounds. Yet they have greatly influenced medical opinion; and, in

[1] R. Boyd, 'Table of Weights of Human Body and Organs,' *Phil. Trans. Roy. Soc.*, CLI, p. 241. The statement is denied by Cunningham, *loc. cit. inf.*

[2] The Sylvian fissure, or dip in the folded surface of the brain, is said to be deeper on the left side than on the right. This condition can be noted in the ape. The most authoritative review of the facts here cited is to be found in D. J. Cunningham's Huxley Lecture for 1902: 'Right-handedness and Left-handedness,' *Journ. Anthrop. Inst.*, XXXII, pp. 273 *et seq.*

particular, have led many doctors to infer a close connexion between left-handedness and speech-defects. In consequence teachers have repeatedly been warned never to train the left-handed child in right-handed habits for fear of 'impairing his speech-centre.'

Even, however, if we admit a prior superiority in the left side of the brain, it still remains to inquire: why is the left side so specialized?

(3) Few writers have faced this question. The only reply would seem to be that all higher vertebrates, although to outward appearance symmetrical in build, are, nevertheless, highly asymmetrical as regards their inner organization. It is scarcely correct to say that the heart is on the left, though its beat is felt mainly on that side: but it is certainly true that the right lung is larger than the left, and more expansible when a great effort requires a deep breath. The liver—a firm and massive organ—lies beneath it, also on the right; and the softer and hollower viscera, like the stomach, are in consequence shifted towards the left. Thus, the centre of gravity of the body is definitely to the right of the middle line. Accordingly (so at least it might be urged) the natural disposition of the warrior or the worker is to rest his bodily weight firmly on the right leg, turn the palpitating heart and vulnerable stomach away from harm's reach, trust to the more solid support of the right side of the trunk, and so use his right hand and arm for wielding heavy instruments and weapons.[1]

[1] Cf. J. Struthers, 'The Relative Weights of the Viscera on the Two Sides of the Body,' *Edin. Med. Journ.*, VIII, 1863, pp. 1c86 *et seq.* For more recent weights and measurements see T. G. Moorhead, *Journn. Anat. and Phys.*, 1902, July. The man who, from palpitation or dyspepsia, becomes over-conscious of the left interior of his body, tends to take up the asymmetrical posture here described; and in childhood, when the weary back gets permanently curved, the curvature is usually convex to the right. This, too, is roughly the position in which (until recently) the soldier 'stood at ease': it will be noted that it leaves the left leg loose and ready to swing forward; while the weight of the right leg might conceivably hinder the lengthening of the bone, for in right-handed persons the right leg is said to be, as a rule, a little shorter. In most armies the place of seniority and honour is on the right, so that the right-hand man has his right arm free, and the next has his right hand ready to support him. When stationary, armies dress by the right, *i.e.* by the senior; when marching, by the left, *i.e.* by the weakest.

Were acquired habits inherited, some such hypothesis might account for the general inheritance of right-handed habits. Since they are not, we must look for some more indirect origin. Thus, some have affirmed that the left half of the brain receives its blood-supply more directly and more freely from the heart,[1] and have even claimed that the left carotid artery is in most persons slightly larger than the right.[2] Accordingly, they have inferred that the nerve-fibres in the left half of the brain must develop their insulating sheaths a little earlier, and that the nerves on the right side of the body—the median and the sciatic—will grow more rapidly and become demonstrably thicker.[3]

These further conjectures, however, are, to say the least, exceedingly speculative ; and the evidence in their support is tenuous in the extreme. It would be easier to maintain that the slight asymmetry in brain-mechanism originally arose from some spontaneous or accidental variation in the germ plasm ; and that, in view of the internal structure of the body, a brain-mechanism that happened to encourage these right-handed, right-footed, and right-eyed tendencies would confer a slight but distinct advantage in the struggle for existence. Thus, families born with an automatic instinct to stand in this way, and to move the right arm first, would find themselves more favourably equipped in any swift and critical operation, such as a tribal combat. On the other hand, a worker or fighter who was perfectly ambidextrous, and possessed equally balanced impulses to use either hand, would cultivate a supreme dexterity in neither, and, when an emergency arose, would stand hesitating like the proverbial centipede, wondering which hand to use. At the same time, the left-handed man, with his centre of gravity badly

[1] The best-known advocate of this theory appears to have been the famous anthropologist, Cesare Lombroso: 'Left-handedness and Left-sidedness,' *North Amer. Rev.*, CLXXVII, pp. 440 *et seq*. Broca suggested a similar explanation for the fact that the speech-centre, which still bears his name, is usually located in the left hemisphere.

[2] Cunningham, however, reports careful measurements designed to test this point (*Report Brit. Ass.* (Anthrop. Sect.), Glasgow, 1901): he found no difference.

[3] Ide, 'On Several Characters Shown by the Cross-Sections of the Median and Sciatic Nerves of Human Males,' *J. Comp. Neur.*, LI, 1930, pp. 457–8.

placed and his more vulnerable side[1] exposed, would labour under a handicap of his own, slight, no doubt, but probably at times decisive. In the long run, therefore, the right-handed stock would survive in greater numbers and so perpetuate its specialized tendencies.

Then, as manual skill became more and more essential in the semi-civilized tribe, this specialization of the two hands would become more and more prized. Primitive communities are sternly conservative; and social opinion would tell strongly against any unlucky left-hander who, by some freak of his innate constitution, failed to conform to the regular preference and the orthodox conventions: so eccentric a fellow might fail to find a mate, or, if he did, his children would be far less likely to hold their own. Even to-day the left-handed fencer or boxer, like the left-handed bowler, has what seems an unfair advantage: the left-handed workman is considered awkward and odd. We are told that earlier societies often ostracized such non-conformists. Many popular phrases and proverbs have come down to us, hinting that left-handedness was held to be a mark of ignominy, ill nature, or an evil star. The Latin word, *sinister*, conveyed and still possesses the double meaning; the French, *gauche*, and the German, *linkisch*,

[1] It is a traditional belief—shared, I find, by army surgeons as well as by army instructors—that wounds on the left are more dangerous than wounds on the right. I have heard of one sergeant-major who, at bayonet practice, proud of his knowledge of anatomy, regularly urged his men to 'jab the other fellow in the stomach and not in the liver.' But to discover statistics supporting such views, or even bearing upon the point at issue, is by no means easy. Certainly, a thrust on the left side is more likely to injure the heart than one on the right. Moreover, figures from post-mortems apparently indicate that injuries and infections of the left lung are more liable to end fatally; and left-sided infections generally are said to be somewhat graver because of the anastomosis of the lymphatics from the focus of infection with the lymphatics of the heart. Such differences must at most be very slight: but the advocate of a 'natural selection' of right-handedness can always remind the more sceptical that a very slight difference may have large cumulative effects, when given 10,000 generations to work upon.

Far-fetched as it may seem, therefore, this explanation, or a cautious modification of it, appears to be the best that the evolutionist can offer in the present state of knowledge. However, until more has been learnt about human mutations and human heredity, it would probably be wiser to refrain from such speculations.

have the same. The left was the unlucky side in augury, as it is in current superstitions to this very day:

> If left-hand fortune give thee left-hand chance,
> Be wisely patient.[1]

We still talk of left-handed compliments, marriages, and oaths. The right hand is the *right* hand in more senses than one.

> The stranger greets thy hand with proffered left?
> Accept not: 'tis of loyalty bereft.
> Left-handed friends are underhanded foes;
> True openness a swordless right hand shows.[2]

Despite the fact that all through human history and all the world over right-handed persons are, as we have seen, more numerous than left-handed, it would appear that in prehistoric races, as in primitive tribes of to-day, the tendency was somewhat less universal than it is amongst ourselves; and the evolutionary theory which I have put forward would account, not only for the widespread preponderance of the right-handed, but also for the gradual increase in their relative numbers.[3]

If we now push our inquiry farther back still and ask why the viscera should be arranged in this specific fashion, the only comment must be that such questions cannot be use-

[1] Quarles, *Emblems*, iv, l. 4. In many country districts, if you happen to spill the salt on the table (like Judas Iscariot in Leonardo's famous picture), you will be told to throw a pinch over your left shoulder, for there the Devil is standing: your guardian angel stands at your right. (Cf. Howell, *English Proverbs*, 1659, 'I gott it ore the left shoulder.' But the superstition both in regard to spilt salt and the unluckiness of the left can be traced at least as far back as the days of Greek and Roman augury.)

[2] Harvey, *Sheep in Wolves' Clothing*, l. 98.

[3] The figures from nearly all civilized countries give 3 to 5 per cent. as the usual proportion of left-handers. Where women or girls have been examined, it is generally added that only half that proportion, or thereabouts, is found in the feminine sex. Rivers and Haddon give nearly the same percentages for several fairly advanced savage tribes. An examination of throwing-sticks yields proportions of 10 to 15 per cent., or slightly larger. McDougall and others who have tested primitive communities where little manual skill is shown, report a decidedly smaller preponderance of right-handed persons. The evidence from palæolithic implements, cave-drawings, and methods of working flints, also suggests a high percentage of left-handers: one observer puts the proportion at least as high as 33 per cent.

fully discussed until we know much more about the processes of early evolution and of embryonic growth. Possibly the chance structure of some chemical molecule far back in the primæval stages of animal life may have produced an accidental arrangement that in itself had no real biological advantage either one way or the other. Strangely enough, persons are still occasionally born with the viscera transposed. Those who have investigated such cases have stated that the transposition is unaccompanied by any effect upon the pre-eminence of the right hand: closely examined, however, their figures suggest a slight correlation.[1] But after all, the astounding fact about the body is not its inner asymmetry but its outward symmetry. Chance would easily lead to asymmetry; but symmetry implies a regulating factor. This factor must evidently be connected with balance and movement. A moving organism, like a motor-car or a ship, may be asymmetrical within: but its outward actions will be far more swift and efficient if its outward form is symmetrical. It is only when we reach the first ventures of manual skill that some division of labour between the two fore-limbs begins to yield a definite gain.

Of all these speculative theories the practical upshot is clear. No vital or overwhelming reason is discoverable to explain why the right hand should dominate in most persons, or why the left hand should dominate where it does. The direct benefit is small and elusive. And this result agrees with the conclusion I have already advanced: namely, that the congenital bias in either direction must be relatively slight, and that its strength varies widely in different individuals. If this be so, the most powerful influences will after all be habit and custom. The few experiments that I have made show that, in most persons, it is far easier to acquire skilled habits with the unfavoured hand than is commonly supposed; and psychological analysis reveals that what trouble there is springs less from the lack of capacity than from the presence of irritating

[1] *E.g.* Pye-Smith reports 28 cases of transposition of whom 23 were right-handed and 5 left-handed. This is about five times as many left-handers as we should expect in so small a group; and the difference is statistically significant.

conflicts. What the learner has to overcome is not merely the clumsiness or inexperience of the unaccustomed hand, but also the tempting impulse to employ the habitual hand.

The teacher, therefore, in his efforts to re-train the left-handed child, has to deal, not so much with a physiological or biological obstacle, as with an unconscious mental resistance. Where the operation to be learnt is wholly new, and no impulse or emotion has as yet become connected with it, the difficulty of educating the less used hand is seldom great. In the woodwork classes at Copenhagen it takes little more than a fortnight for the average pupil to learn to hammer, bore, or saw with either hand. Many modern machines—the typewriter, for example—and several ancient instruments—like the harp, the piano, the violin—require as much speed or dexterity in the left hand as in the right : and, in everyday life, though civilization is rigid enough about some one-sided activities—for example, shaking hands, its practice is arbitrary in regard to others. The buttons on men's clothes are to the right ; on women's clothes they are to the left : yet neither sex complains of any hardship. In England the traffic keeps to the left of the road ; on the Continent mainly to the right ; in one half of Austria to the right and in the other half to the left : and no one seems so far to have finally decided on which side of the car the driver had better sit or even on which side his gear levers should be placed. Nor does it need much astuteness to perceive that most people really use their unfavoured hand far more frequently than is commonly assumed.

Habit, then, after all, is the chief process with which the teacher will be concerned. If he begins early enough, he will have no stereotyped habit to destroy, and the new one will be easy to instil. But besides habit, and besides heredity, there is yet a third factor, which, all too often, remains ignored and unsuspected—the temperament of the left-handed child.

The Temperament of the Left-handed.—In summarizing the statistical results of my surveys I have already shown that left-handedness is decidedly commoner among neurotic children ; and, as we have incidentally observed, alike in congenital and acquired cases of left-handedness, tempera-

mental peculiarities are constantly found. These peculiarities are themselves significant. Although I have no conclusive figures to offer, all my experience confirms the impression that, when temperament and left-handedness are intimately related, the peculiarities and neurotic symptoms generally take what I have called the sthenic, aggressive form rather than the asthenic or submissive.[1] Again and again in my case-summaries the left-handed child is described by those who know him as stubborn and wilful. At times he is visibly of an assertive type, domineering, overbearing, and openly rebellious against all the dictates of authority. But more often his aggressive tendencies are concealed or repressed ; and the child belongs to a class well known to practising psychiatrists and familiarly dubbed by them 'obstinate introverts.' Analysis or psycho-analysis will sometimes show that the left-handedness itself rests on an unconscious neurotic compulsion : the dogged adherence to a perverse way of writing symbolizes, as it were, a secret desire to defy all conventions ; and frequently the teacher or parent will remark that the child is highly contra-suggestible, or—to use their own favourite phrase—'just cussed,' in many other ways.

A shrewd mother once volunteered the account of how she had chanced on this motive for herself. At lunch her six-year-old boy, who was supposed to be incorrigibly left-handed, had unexpectedly seized his knife and fork with the proper hands. His nurse, from sheer force of habit, called out sharply : 'Now, Roger, put your knife in your other hand.' 'I can't,' said the boy, 'and if I did, I couldn't cut !' And so, all through the meal, he continued cutting his food with the right hand—a hand he had hitherto refused to exert for this purpose.

Even left-handed girls, as a little watchfulness will show, often possess a strong, self-willed, and almost masculine disposition : by many little tell-tale symptoms, besides the clumsy management of their hands—by their careless dress, their ungainly walk, their tomboy tricks and mannerisms—they mutely display a private scorn for the canons of feminine grace and elegance. In both sexes this refractory

[1] For the distinction, see *The Subnormal Mind*, pp. 215 *et seq.* and p. 269.

wilfulness is most frequently to be discerned in what I have called left-handers of a temperamental type; yet it may also at times be detected among children in whom— if the evidence can be trusted—the left-handedness is congenital and even inherited. Hence it is but fair to add that this hardness of character may be quite as much an effect as a cause. It may itself have been built up as a reaction against early and repeated remonstrance upon this very point. Accordingly, the old-fashioned teacher was not wholly unjustified in assuming that, when his left-handed pupils declined to employ their right hands, it was not because they couldn't, but rather because they wouldn't. His mistake lay in failing to perceive that his own insistence was more likely to reinforce this obstinacy than to dispel it.

My final conclusions, then, are these. After examining both the statistical data and the various arguments advanced by independent theorists, we are forced, I think, to admit that the causation of left-handedness is far more complex and far more obscure than has hitherto been assumed. Among children of school age three main factors seem to stand out—heredity, habit, and a half-unconscious perversity. But their importance differs widely in different cases: and a proper understanding of each one is a necessary preliminary to treatment.

IV. *Treatment*

Consequences of Left-handedness.—There can be no doubt that in school left-handedness tends seriously to impede a child's general progress. It may, therefore, easily prove a genuine cause of backwardness. Not only manual activities, such as writing and drawing, but also—what is far less commonly realized—even reading, spelling, and composition, in fact, every subject of the curriculum may, in certain cases, suffer as a result.

At the early stages the left-handed child is very liable to confound shapes or curves that turn to the right with those that turn to the left, particularly if he uses for the self-same purpose now the one hand, now the other. Thus, when he first starts learning to write or read, he is apt to mistake—far more than the normal child—letters that face towards

one direction for similar letters facing towards the opposite, *b* for *d*, *p* for *q*, and vice versa. Later, he may become uncertain about the order in which letters should be written, or figures set out for calculation. Sometimes he will work his subtraction sums from right to left when using his right hand, and then from left to right when using the other hand; so that he ends in chronic bewilderment, no matter which hand he employs. Nearly always, whether old or young, the left-handed writer pens his lines more slowly. In actual tests for quickness, I find that on an average the left-handed reach only four-fifths of the speed of the right-handed. This means that, other things being equal, in the written exercises of the classroom or at a written examination, the right-handed pupil can get through 20 per cent. more work in the same amount of time.

Direct and visible results like these will have been noted by every observant teacher. But the less patent effects—the inner, indirect, and temperamental consequences—are even more prejudicial. Day after day, at his desk in the schoolroom, at his games in the playground, over the dinner-table at home, the left-hander feels, and is made to feel, that he is peculiar, that he is not as other children are, that he is distressingly different, unable to do the most ordinary routine actions in the same natural way as the rest. Perpetually corrected, he gradually acquires a permanent and oppressive distaste for every lesson, task, or pastime, in which his hands have to assist; and, if harsh methods are publicly used, he may come to hate school and human companionship altogether, and grow egocentric, moody, and full of secret resentment.

Need for Preliminary Investigation.—What, then, is the teacher to do? Is every child to be urged to use his right hand in the traditional way? Or should each be free to follow his private preference, unhindered and unrebuked?

Since the factors at work and the difficulties to be encountered differ so much in different individuals, no universal rule can be laid down. The teacher must learn to discriminate between the various cases. Five points at least must be taken into special consideration: first, the apparent strength of the innate impulse; secondly, the age and

fixity of the left-handed habit; thirdly, the dexterity or lack of dexterity shown by the right hand; fourthly, the practical handicap that the individual child may suffer in after-life, if allowed to grow up left-handed; and last, but most important of all, the child's individual temperament.

To begin with, by applying the tests described above, and, so far as possible, by reviewing the child's personal and family history, the teacher should ascertain whether the dominance of the left side appears to be inherited or inborn, extending, more or less consistently, to every action and perhaps to the whole bodily organization of the child, or whether, on the other hand, the left-handedness affects but a few routine activities, and is unaccompanied by any sinistrality in eye, leg, or other functions, in the end perhaps proving to be the sole instance discoverable in the family, and so presumably attributable to accident or late-developed habit. Too much weight, however, must not be attached to its seemingly innate character. No instinctive tendency becomes fixed except through exercise; and the teacher should bear in mind that, whatever may be the precise congenital basis for the preference, a persistence in preferring the right hand or the left is undoubtedly more a matter of habit than of physiological necessity. Every schoolmaster must have known one or two right-handed children who have had the misfortune to injure the right hand or break the right arm: such a child is then obliged to train himself to be temporarily left-handed. Here the change of hands entails no worry, no strain, and no exhausting effort.[1] I have made the most careful inquiries; and I

[1] Doubtless, the fact that the other hand is unavailable prevents a good deal of conflict; usually the child is a little proud rather than ashamed of his defect, and wins sympathy instead of rebuke. I myself, however, can provide instances where the original change has been almost as easy without the aid of an accident, and later caused conflicts of its own during the efforts to change back again. When as a child I first learnt to cycle, I mounted and dismounted, like most people, from the left-hand side of the machine. Later it seemed desirable to practise doing so from the opposite side. I practised assiduously; and then found to my astonishment that, in cultivating the new habit, I had also formed a new impulse. It proved singularly difficult, and, indeed, almost annoying, to go back to what at first had been the more natural mode. A friend tells me that during a long journey abroad,

have never yet struck a solitary instance in which learning to use the left hand in this way has been attended by any untoward disturbance either of speech or of nervous equilibrium.

Since permanent left-handedness results from custom rather than from an inherited compulsion, early vigilance is always necessary, unless the custom is to become set. If the child is young, it is improbable that the habit is as yet very firmly rooted: to effect a change at the age of six is far simpler than at the age of ten. The later the training is deferred, the harder it will be to break the wrong habit, and to substitute a correct one. Save, therefore, in exceptional cases, the matter should never be left until the child comes up to the senior department, and by preference should be dealt with before ever the child enters school.

From time to time, parents who are themselves left-handed or aware of a strong left-handed tendency in their families (sometimes conjoined with stuttering) inquire about the risks of a right-handed training for their babies. My general recommendation is that the right-handed habit should, if possible, be established before the child starts to speak. This can best be done by placing any articles that he is likely to want near his right hand and out of reach of his left: *e.g.* by turning his chair, or by moving his table, so that the table is by the right-hand side of his body. Where this advice has been accepted, and I have been able to keep in touch with the case during later years, the child has shown no discernible inclination either towards left-handedness or towards stuttering.

The success of all such training, whether during babyhood or the first few years of school life, will depend largely upon the educability of the right hand itself, or, to speak more accurately, of the nervous and muscular mechanisms that control it. Accordingly, either by short trial tests, or

when apparently his wardrobe was limited, he tore a large hole, which he omitted to mend, in the right-hand pocket of his trousers. He therefore developed a habit of keeping his money in the left-hand pocket; and the habit has persisted, so that for this particular purpose he is still left-handed, even though his wife now keeps his clothes intact. His efforts to return to the more convenient pocket have only caused an irritating indecision, and have been abandoned.

better by a little experimental practice, the psychologist or teacher should try to determine at an early stage how far the child is educable in this respect. The supposedly left-handed child, who is merely clumsy and unpractised with his right and not very dexterous with either, is a case for cautious exercise in right-handed habits. The child who is genuinely left-handed, and left-eyed and left-legged as well, will often show a marked difference in educability between the right hand and the left, and will frequently resist the best-planned endeavours.

At older ages the teacher should think primarily of the type of employment the lad is likely to take up on leaving school. If, in his probable trade or profession, left-handedness can impose no handicap or disadvantage, then, at this late stage, it will hardly be worth while to start a prolonged and strenuous struggle to effect a revolution in old-established habits.

With the neurotic and unstable particular care must be exercised. A history of stammering, nightmare, or insomnia, together with the child's sensitive manner in the classroom, may betray whether the left-handedness is itself a symptom or effect of some underlying nervous disturbance. But since so many left-handed children are prone to develop temperamental symptoms, too strict an insistence upon the right hand, at any rate by repressive and reproachful methods, is always to be deprecated, even when no special danger-signals have been noticed.

It is, then, more especially in what seem to be congenital, temperamental, or long-standing cases, that the teacher will have to use his individual judgment and proceed with the utmost caution. With these reservations, it is my opinion that, as a general rule, every child should be taught, so far as possible, to use the right hand, if only in view of his after-life.

Almost the whole apparatus of our civilization—from the door-knobs in the house to the steps on the bus, from the lathes in the workshop to the handles on egg-beaters, sewing-machines, gramophones, and the like—all is designed on the assumption that we are a right-handed population. Hence, anyone who grows up left-handed is bound to be

penalized in a hundred directions. In many trades there is a strong prejudice against the left-handed workman: most factory machines can be worked only by a right-handed operator; banks and engineering firms will often reject an applicant simply because he cannot use the right hand for writing, drawing, or manipulating tools. With a few older children whose future vocations are already decided, it may be safe to assume that their careers will not be endangered by left-handed habits: and I have known more than one young tennis-player and several ambitious cricketers who claimed such habits as a permanent asset. But, in general, unless there are sound reasons for making an exception, parents and teachers will in the long run earn the gratitude of the child if they do all they can to make him right-handed from the very start.

Influence of Right-handed Training on Speech.—One current objection must be finally disposed of. As we have seen, it is popularly supposed that any interference with the nervous mechanisms that govern the hand is likely to spread to and damage the nervous mechanisms that govern the child's speech, so that teaching the left-handed child to use his right hand is liable to precipitate a stammer. So excellent an authority as Terman declares: 'Left-handed children should remain left-handed, for writing at least; the slight advantages that would accrue from the change are entirely outweighed by the dangers to speech.'[1] How far are such apprehensions justified?

That disorders of speech are more prevalent among the left-handed, we have already acknowledged. But what does this mean? Is their prevalence directly connected with left-handedness as such? Or does it merely arise from the attempts to compel the left-handed to become right-handed? Or, lastly, are both the speech-defect and the left-handedness due to some third underlying cause, of a deeper and obscurer nature?

(*a*) *The Argument from Statistics.*—A few further statistics may help us to answer these questions. Let us take, to begin with, the left-handers of normal intelligence, and compare the figures for speech-defects, first among those who have

[1] *The Hygiene of the School Child* (1914), p. 346.

been allowed to write with the left hand, and secondly among those who have been trained to use the right. In my own survey the proportions are 4·2 per cent. and 6·1 per cent. respectively. Thus the difference, though perceptible, is not very great: among left-handers who now habitually use the right hand, disturbances of speech are less than half as common again. Next let us turn to the backward left-handers. Here the difference is far greater: stuttering is more than twice as common in those who have learnt to use the right. The percentages are 6·2 and 13·9 respectively.

But, before we draw any conclusion, let us first sort out the records according to the date of the inquiry. At once it appears that the difference is very much smaller in those surveys made recently as compared with those that were carried out some ten or twelve years ago. Most significant of all are the wide divergences between different schools and different districts. In those more tolerant schools where the left-handers are permitted to remain left-handed if they wish, the pupils who have actually changed over to the right show no excess of speech-disorders: the percentage of stutterers among the left-handed is only 4·3 per cent. In other schools, where the rule is rigidly enforced that every child should use his right, stuttering is disproportionately abundant among both the right-handed and the left-handed: the figures are 6·6 per cent. and 8·0 per cent. respectively; the fact that the percentage is somewhat higher among the left-handed is sufficiently explained by the greater liability to stammering that the left-handed always exhibit. It is, therefore, difficult to withstand the inference that, in the main, it is the general severity of the school discipline—of which the insistence on right-handedness is but a sample—that is really responsible for an excess that appears equally evident in both the right-handed and the left-handed groups.[1]

[1] In America an extensive survey by Wallin in the schools of St. Louis revealed that, of the left-handed children taught to use the right hand, over 90 per cent. showed no speech disturbance; in the New Jersey schools, although every child is required to write with the right hand, stuttering is declared to be almost entirely absent; in an investigation of over 1,000 one-armed individuals not a single case of stuttering was discovered (Kistler, *Schweizerische Medizinische Wochenschrift*, LX, 1930, pp. 32 *et seq.*).

The dullness of the backward pupil no doubt makes the struggle more arduous, since, as we shall see in a later chapter, the dullard always finds it harder to achieve new adjustments or to learn new acts of skill. But, when we look closer at the individual child himself, the obstacles that stand most prominently in the way are not his intellectual but his emotional disabilities. Among the 6·5 per cent. described above as being stuttering left-handers, four out of every five were demonstrably of a neurotic or unstable nature ; and a milder lack of temperamental balance—in some instances, it must be admitted, appearing rather as a consequence than as a cause of the speech-defect—was inferred or suspected in nine cases out of ten. It was chiefly within this special neurotic group that the uncompromising enforcement of right-handed activities had, so it seemed, conduced to stammering ; and, as a rule, the stammering was but one, although the most conspicuous, of several resultant disturbances in the more delicate adjustments of the nervous system.[1]

In point of fact, however, the notion that right-handed

[1] The connexion has most clearly been shown by the three extensive inquiries carried out by Ballard. In the last—a survey made in 1911 where the relevant cases were personally examined—he found, among about 12,000 school children, only 51 pure left-handers, none of whom stammered. Among 271 'dextro-sinistrals'—left-handers required to use the right hand—70 suffered or had suffered from speech-defects. The inference has been drawn that, in such cases, trying to convert the sinistral into a dextral has resulted in speech-disturbance : and that 'one-third to one-half of the stuttering among London school children is produced in the effort to make right-handed children out of those who are normally left-handed' (Terman, *loc. cit.*, p. 346). My own experience would rather suggest that the stuttering dextro-sinistrals were examples not so much of marked left-handedness as of impaired co-ordination in the right, the speech-defect itself being another symptom of the general impairment of muscular delicacy. In any case, it will be observed, the vast majority of the left-handers required to write with the right—74 per cent.—showed no signs of stuttering. Dr. Kerr, formerly school medical officer for London, declares that he has never seen an instance of stuttering produced in the manner alleged (*Fundamentals of School Health*, 1926, p. 629. For illuminating discussions of inquiries carried out mainly in London, see Ballard, 'Sinistrality and Speech,' *J. Exp. Ped.*, I, 1912, pp. 298 *et seq.* ; Kerr, 'Left-handedness and Mirror-writing,' *School Hygiene*, 1920 (Feb. and May) ; Gordon, 'Left-handedness and Mental Deficiency,' *Brain*, XLIV, 1921).

training might generate a stammer seems originally to have been derived, not from statistical inquiries or systematic case-study, but from somewhat dubious inferences from anatomical or physiological theory. Such arguments are still quoted by doctors, teachers, and occasionally even by psychologists; and therefore call for a brief examination here.

(*b*) *The Argument from the Proximity of Speech and Hand Centres.*—In its earliest form, the deduction was based on the view that complex activities of the mind or body, such as those of speaking or skilled hand movement, were controlled by definite 'centres' in the brain. According to the popular maps of cerebral localization,[1] the 'centre for speech' was placed on one side of the brain not far from the 'centre' for the more dexterous hand: in right-handed persons both were assigned to the left hemisphere; and in left-handed persons both, it was declared, were in the right. It was accordingly inferred that, in consequence of the mere anatomical proximity, a disturbance of the hand-centre might flow over to the speech-centre.

I doubt whether any competent authority would nowadays accept such an argument. First, proximity is a very misleading description. The two 'centres' may be separated on the surface of the cortex by no more than a couple of inches; but, when we consider that the cells of the brain have to be measured in ten-thousandths of an inch, a space of two inches becomes as vast as the distance between London and Edinburgh on a railway-map of England. Would a tidal wave in the Firth of Forth disturb the organization of King's Cross Station? And in any case why are the intervening 'centres'—those for movements of the head, face, and eyes, for example—left so completely unaffected? Secondly, the brain is no longer conceived as possessing self-contained, quasi-phrenological 'centres.' The so-called 'centres' are merely 'areas within which specific systems of projection fibres' (that is, nerve-fibres running in or out of the brain) 'make their cortical connec-

[1] The usual form of such maps is shown by the figure reprinted in James's *Principles of Psychology* (Vol. I, p. 57, fig. 18) and in Kerr's *Fundamentals of School Health* (p. 612, fig. 121).

tions in switchboard fashion; but neither these centres, nor any sector of the intervening associational tissue, can be thought of as performing any one of the distinctly higher cortical functions in isolation. . . . Most of the charts of functional localization of psychological or other complex functions are misleading fictions.'[1] Accordingly, more recent neurologists are inclined to regard disturbances of speech and disturbances of manual co-ordination, when found in one and the same person, simply as the two most conspicuous instances of a more general disturbance of nervous organization, tending to affect the 'brain,' or rather the nervous system, as a whole.

(*c*) *The Argument from 'Dominant Gradients' in the Cerebral Hemispheres.*—In a more subtle form, however, this theory has lately been revived and expressed in physiological rather than anatomical terms. It is admitted that the so-called speech and hand centres are really 'nothing but relay-stations on a complex network of tracks leading into and out of the brain.' But, it is argued, a fundamental feature in all higher nervous organization is 'the principle of the common path.'[2] This principle

[1] C. J. Herrick, *Brains of Rats and Men*, University of Chicago Press, 1926, p. 249. I select the quotation given in the text because it is cited as representative of the best available opinion by the writers of the newest textbook of psychology (Boring, Langfeld, and Others, *Psychology: A Factual Textbook*, 1935, p. 28). The statements of nearly all contemporary physiologists and psychologists are to the same effect: *e.g.* 'There are no "centres" for speaking, reading, writing, or other forms of behaviour comprised in the normal use of language' (Henry Head, 'Speech and Cerebral Localization,' *Brain* Vol. XLVI, p. 359; cf. id., *Aphasia and Kindred Disorders of Speech*, 1924) "The function of speech, as of all other specialized functions, involves the act;ivity of the whole brain' (A. E. Davis, 'Speech Reactions and the Phenomena of Aphasia,' *Psych. Rev.*, No. 33, 1926, p. 429). It is interesting to note that this interpretation of cerebral localization was strongly expressed forty years ago by James. 'There is no "centre of speech" in the brain any more than there is a "faculty of speech" in the mind: the entire brain, more or less, is at work in a man who uses language' (*Principles of Psychology*, 1890, I, p. 56).

[2] The formulation of the principle is due essentially to the work of Sherrington (*Integrative Action of the Nervous System*, 1906, p. 115); but it seems clear from his general exposition of it that he would not accept the modified interpretation assumed by the argument set out above. To those who are unfamiliar with current physiological conceptions of the working of the

implies, so at least it is urged, that for smooth and efficient working the nervous energy must discharge down one dominant gradient. If the two sets of paths leading from the two hemispheres of the brain were equally open to nervous discharge, a conflict or a confusion of movements would inevitably ensue. Hence nature has arranged that one hemisphere—in most individuals the left—shall dominate over the right. In a few, however, namely, those who are naturally left-handed, the right hemisphere tends to dominate over the left. If, therefore, by training these left-handed individuals to use the right hand we increase the gradient in the left hemisphere, the original dominance will presumably be destroyed; and the result will be an incoordination in all the finer movements concerned.

As applied to the phenomena of stuttering and left-handedness, this hypothesis has been developed by Edward Lee Travis, and has attracted considerable interest because of the apparent success that has attended therapeutic measures based upon it.[1] Travis declares that his laboratory tests show that most stutterers are native left-handers who, with or without effort, have come to use the right hand instead of the left, often quite apart from any explicit social pressure. Thus their acquired motor facility is 'out of harmony with their native physiological lead.'

The process by which this lack of harmony is supposed to

nervous system, the notion of a 'dominant gradient' may present some difficulty. It should therefore be explained that nervous energy is commonly thought of as flowing in insulated currents towards the muscles along paths provided by the nerve-fibres, much as water will flow down a slope, or an electric current will flow from a point of high potential to one of lower, by the line of least resistance. The greater the slope or gradient, or the lower the resistance along a particular path, the more likely is the current to run in that direction. Hence the direction of the currents is said to be determined by the dominant gradient. Which particular gradient is dominant at the moment, however, must depend in the main, not on the persistent permeability of paths leading from one hemisphere rather than from the other, but on the degree to which each separate path or group of paths has been opened up either by previous use or by its inherited nature, and still more on the whole changing pattern of resistances, reinforcements, and deflections—in short, on the general dynamic interrelations between the various systems and circuits at the time of discharge.

[1] See Edward Lee Travis, *Speech Pathology* (Appleton & Co., 1931).

be brought about may be roughly described as follows. Until the child begins to write, the use of language presumably involves the activity of both hemispheres, for he uses both ears to hear speech and both sides of his face, mouth, and throat in talking.[1] But when he is taught to write, he has for the first time to employ an asymmetrical or one-sided mechanism. Speech is bilateral; writing unilateral. In forming their letters, most children are taught to use the right hand; and this must involve predominantly motor centres on the left side of the brain alone. If the child is by constitution right-handed, the necessary training of the right hand will cause him no special difficulty. If, however, he is left-handed and is nevertheless taught to write with his right, then, it is said, two gradients or paths of discharge are imposed upon his brain; and his whole motor mechanism, or at any rate that part which is concerned with language, will be thrown into disorder.

Thus, the stutterer is conceived as one who lacks a dominant trend for the outflow of his nervous energy. 'During stuttering,' we are told, 'the right and left cerebral hemispheres are equipoised.'[2] On this hypothesis, the primary causes of stuttering are declared to be: '(1) lack of an inherent bias for the development of a sufficiently dominant gradient of excitation in the central nervous system to integrate the movements of the organism in the production of normal speech; and (2) environmental interference with the development of a sufficiently dominant gradient of excitation in the central nervous system to

[1] The fact that in right-handed adults the 'speech centre' is apparently on the left side of the brain has led many writers to assume that the left hemisphere, as a whole, is from the outset more delicately organized, and that the one-sidedness of the speech centre is innate. Were this so, we should expect motor aphasia to be commoner in those early instances of hemiplegia in which the right side of the body rather than the left is affected. Early cases of motor aphasia, however, are rare; and there is so far no conclusive evidence in favour of this deduction. Indeed, several authorities maintain that aphasia from a lesion affecting solely the left hemisphere is seen only in those cases where the patient has already learnt to write with the right hand; in illiterate adults, it is said, aphasia may ensue from lesions on either side.

[2] *Loc. cit.*, p. viii.

integrate the movements of the organism in the production of normal speech.'[1]

The practical corollaries to be drawn from this theory for the treatment both of left-handedness and of stuttering are obvious. The left-handed child must be encouraged in his left-handed ways, since any attempt to inculcate right-handed habits is likely to precipitate a stutter. The stutterer must be re-trained to use the left hand rather than the right, since only in this way can we expect to 'unify the motor leads,' that is, to build up 'a single dominant centre of activity in one of the two cerebral hemispheres' which shall be in unison with his natural physiological gradient.[2]

The hypothesis, however, on which these recommendations rest cannot possibly be accepted without far more direct evidence in its support than has hitherto been adduced. To assume that right-handed training may influence speech is to assume a spread or transfer of the effects of training such as is quite inconsistent with the extremely limited degree of transfer observed in every mental field that has hitherto been studied. It is true that one form of training may hinder as well as facilitate other forms; but such obstruction seems only to occur when the two forms are closely allied. The mere fact that both writing and speech are normally governed by one side of the brain provides a very weak ground for expecting any direct interference from activity of the opposite side. No doubt, for a few specific types of movements the action of symmetrical areas or 'centres' on the left and the right side of the brain appears to be, in a greater or lesser degree, antagonistic; but for others it is not so. Thus, it is far harder to turn both eyes symmetrically outwards, or even to turn both symmetrically inwards (as in a voluntary squint), than to turn both to the right or both to the left; on the other hand, to execute symmetrical movements with both hands simultaneously is far easier than to execute similar movements. Such incompatibilities, however, seem rather to be a secondary consequence of the structural organization of the body than a direct and immediate result of the structural organization of the brain.

[1] *Loc. cit.*, p. 255. [2] *Loc. cit.*, p. 56.

In point of fact, for a far greater number of physical movements, the activities of corresponding motor areas on opposite sides of the brain are co-operative rather than inconsistent, and in others perhaps are entirely neutral [1]; and, when the movements alleged to interfere with one another are carried out on entirely different occasions and concern entirely different parts of the body, the assumption of a mutual inhibition between the two hemispheres of the brain seems exceedingly far-fetched. The violin player, for example, learns to execute highly delicate actions with the fingers of the left hand, though all his skilled finger movements hitherto have been executed with the right; the young pianist learns to employ both hands with almost equal dexterity: yet in neither case have I ever heard of any disturbance accruing to speech.

The fact is that when the hand movements are connected with other tasks than writing no one seems to anticipate any serious trouble. In lessons on needlework, woodwork, and other forms of handwork, where the left-hander is often trained to use his right hand like other children, stuttering is rarely if ever mentioned as a direct effect of the training. One point, therefore, overlooked by the physiological hypothesis is this: writing is not merely a manual exercise in which one-sided 'brain centres' play an essential part: it is also an activity closely allied to speech itself, both in the intellectual processes and emotional attitudes involved and also in its general psychophysical nature. Writing is, in fact, a form of speech, and a form much more difficult for the young child to acquire than talking or reading. Moreover, when the mode of execution is peculiar or when the results seem clumsy and uncouth, it is the very type of manual skill most apt to provoke comment and criticism from others and to cause embarrassment to the child himself.

These considerations raise a question which has almost always been overlooked: is it not far more likely that the cause of the stuttering is not so much the use of the right hand in place of the left, but the strain of substituting written words for spoken words, of trying, as it were, to

[1] For a summary of the experimental evidence on such points, see Sherrington, *loc. cit.*, pp. 289–90.

communicate with the hands instead of the lips? After all, it is only natural that this new method should at times upset the old, and that quite regardless of the particular hand employed for the purpose, except in so far as the use of an ill-adapted hand would aggravate the difficulty still further.

In a later chapter I shall give an analysis of the cases of stuttering encountered during my surveys; and we shall find that there is an appreciable number of instances in which the stuttering has apparently been precipitated just about the age at which children are first taught to write.[1] Like all groups of stutterers, such a group inevitably includes an enlarged proportion of left-handed children; and, since under old-fashioned methods all children were taught to write with the right hand, it is not surprising that, in the earlier instances more especially, the teacher, doctor, or inspector often attributed the stutter to forcing a left-handed child to use the right hand. Careful testing, however, showed that one case out of seven was definitely left-handed and at least four-fifths were definitely right-handed. Hence, even if valid, the explanation would only cover a small proportion. In the more recent instances, particularly those observed during the period when headmistresses of infants' schools had been warned to leave the left-handed to his left-handed ways, it still seemed evident that the difficulty of writing in itself, irrespective of the hand employed, might at times induce symptoms of nervous strain.

But why should the nervous strain manifest itself so often by a stutter? The first answer is that stuttering is one of the commonest, as it certainly is the most conspicuous, symptom of nervous strain in young children: it would be wrong to suppose its appearance is in any way limited to difficulties over writing. In the second place, in a few cases it is possible, not only to show that the strain of writing may at times be specifically connected with speech disturbance, but even to trace the way in which it operates. To get further light on the problem, I have persuaded some of the brighter children to make an effort of introspection and describe their actual experiences. From their reports it would appear that, in such cases, the cause is often to be

[1] See below, pp. 365-7.

found, not so much in the neuro-muscular process itself, as in its intellectual and emotional accompaniments. Many children, as they write, say over to themselves the letters or the words that they are putting down on paper. It seems, therefore, that their first endeavours at writing often tend to slow down their natural pace of speaking, and even to set up little habits of hesitation and repetition. Any additional cause which renders writing difficult (and left-handedness is only one) may in this way still further upset the mental mechanisms connected with fluent speech: with emotional children, the worry and struggle that they then experience in getting their internal speech down on to paper may easily spread to all situations in which verbal expression is employed. On these as well as on more general grounds I conclude that the conflict responsible is not a conflict between two hemispheres, but a conflict between two interfering tendencies relating to one and the same sphere of mental activity.[1]

When we turn from the younger left-handed stutterers of

[1] When the hesitation turns into a definite stammer, there seems almost invariably to be some predisposing factor in the background—*e.g.* a hereditary tendency in the family, or one of the many other influences that we shall notice when analysing the causes of stuttering. I have observed similar results quite as frequently among children where the difficulty in writing arose, not from using a relatively unskilled hand, but from changing from one style of writing to another. An instructive case is that of a bright boy of seven who at home had learnt to scribble stories and the like at a rapid speed in a careless hand, and was then forced, when he went to school, to write more slowly and more neatly: he developed a stammer which vanished as soon as he was allowed to scribble at his own speed and in his own fashion. I have records of five instances of temporary stuttering among children who changed from a style of writing learnt under one teacher to another style of writing favoured by a second—*e.g.* from printed script to cursive, or from a running hand to print: in two of the cases there was no change of class teacher, since the alteration was introduced by a headmistress who had been attracted by the new methods of writing. My attention has also been drawn to two instances in which youths who were learning to typewrite also developed a stammer.

An analogous interference is frequently reported by older persons who at a certain stage of their lives find themselves condemned to do most of their verbal work on paper. The author who spends much of his time over his manuscripts, the lecturer who writes out his lectures in full, the man who has to answer numerous letters every day, constantly declare that their speed of

the infants' school to older cases where the stuttering develops a few months after the child has entered the upper department, the predominance of the psychological factors is still more obvious. The largest number of instances in which right-handed writing seems suddenly to produce a stutter are found at about the age of eight, that is, just after promotion. This, indeed, is the period which is marked by a greater increase in stuttering than any other single year. The majority of the cases are not left-handed at all; and among those who are, the greater proportion have already learnt right-handed writing in the infants' school. But there is a small and definite group in which pupils who had been allowed to write with the left hand in the infants' school are now required to change over to the right (this group has appreciably diminished in number during recent years). In considering such cases it is essential to compare the remaining instances of left-handedness in which the new method of writing has not precipitated a stutter. On making an individual study of each child, three factors stand out: in the former group there is usually either (1) a history of stuttering in other members of the family, or (2) a history of other signs of emotional instability in the child himself, or else, most commonly of all, (3) a demonstrable degree of tactlessness on the part of the teacher who has enforced the right-handed methods. Here, therefore, what counts is the manner of the training rather than the training itself. Daily nagging will engender a state of continual nervousness and worry. Harsh methods of correction will intensify the child's secret shame at being different from his fellows, and so set up just that kind of social fear which leads to hesitant and stuttering speech. And the clash between the old habit and the new requirements so rigidly imposed precipitates a general mental confusion.[1]

This conclusion is confirmed by the fact that, as the case-

thinking (and with them thinking is usually a form of inner speech) is slowed down to the pace of their handwriting. Later on, when they employ secretaries, and dictate instead of writing, their thinking and their talking resume a more natural rate.

[1] I may add that this is the explanation preferred by so eminent a neurologist as Sir Henry Head.

histories amply show, other emotional disturbances besides mere stuttering nearly always ensue. Not infrequently there are more general symptoms characteristic of chronic anxiety and of inner conflict and strain—sleeplessness, sleep-talking, nightmares, and the like. Almost as often, however, the disturbances take the form of petty delinquency, bad temper, irritability, and spells of disobedience.[1] It may be observed, too, that a history of stuttering is quite common among the relatives of the left-handed child even when he himself does not stutter, just as a history of left-handedness is often found among the relatives of the stuttering child even when he himself is not left-handed. In short, both the tendency to left-handedness in its various manifestations, and the tendency to stammer or stutter, must be regarded as forming but two among many alternative signs of a general lack of stability in the child's whole nervous organization; and, like all such tendencies, both are apt to be aggravated by emotional stress.

Although I cannot accept the hypothesis by which it was suggested, it is impossible to deny that the methods proposed by Travis, and by those who have adopted similar views, appear at times remarkably beneficial. In my experience, it is chiefly with left-handed children of a neurotic type, particularly those with a family history of stuttering, that the reversion to left-handed writing is most commonly

[1] It has often been alleged that, whereas other stutterers are of an obviously nervous type, the left-handed stutterers frequently are not: they have nothing of the shy, shrinking, over-sensitive nature associated with the ordinary stutterer. This fact has been used as an argument for concluding that in the latter case the stuttering is attributable to a physiological rather than to an emotional mechanism. The inference, however, springs from a restricted and erroneous notion of what the neurotic temperament really covers. The popular picture of the neurotic child includes only those who suffer from anxiety neuroses and kindred disorders. As we have seen (above, p. 317), the left-handed child tends more often towards the assertive and domineering temperament than towards the shy and timid. But both kinds of temperament, when exhibited to excess, denote a high degree of nervous tension. In my own experience, when stuttering occurs in a left-handed child, both the stuttering and the left-handedness sometimes demonstrably rest on a kind of compulsion-neurosis, which yields to psychotherapeutic treatment, like other neuroses more widely recognized as such.

followed by a cure.[1] But the benefits, like the facts on which they are based, can be explained just as well along psychological lines as along physiological. When a child who is naturally left-handed is set to do left-handed exercises in writing and the like, his interest is at once aroused. He feels that his left-handedness is no longer under a taboo—no longer branded as a source and sign of personal inferiority. He is provided with a new and congenial task which absorbs his attention and which rapidly leads to satisfaction and success. Thus his mind is diverted from the problem of speech; and the interest taken in his case and in his own individual progress tends to heighten his general self-confidence. This explanation is further corroborated by the fact that, when the new habit has been effectively established and the pupil is left to himself, the stuttering sometimes breaks out once again.[2]

[1] In this country an interesting experiment, somewhat along the lines of Travis's methods, was carried out by Mr. Hugh Gordon, one of H.M. Inspectors of Schools (for a brief account see *Times Educational Supplement*, 1929, May 6th). At the special schools in the Lingfield Colony for Epileptics, a group of children who were stationary in learning were given a training in left-handed work in the hope that ' additional centres in the brain might be opened up.' It was found that after a few months many began to stutter ; and these appeared to be chiefly those who were making the greatest progress. But, so long as the left-handed movements were of the nature of mirror-writing, *i.e.* so long as the left hand worked in the direction most natural to it, there was no disturbance of speech. At first sight this might seem to confirm some such hypothesis as that put forward by Travis. Closer study of the results, however, led Mr. Gordon to abandon the left-handed training in favour of ambidextrous exercises. The speech defects then disappeared. If, with Travis, we assume that the dominance of one or other hemisphere is essential for efficient speech, then it is difficult to explain the improvement that followed the ambidextrous training, since that would involve the activity of both hemispheres at once. The most natural inference would seem to be that these various exercises ' opened up,' not ' additional centres in the brain,' but additional interests in the child's scholastic life. The incidental stuttering is explicable by the strain put upon a child already highly unstable ; among epileptics, stuttering frequently follows any new task that imposes mental conflict and exertion, whether the ' hand centres ' are concerned or not.

[2] In the treatment undertaken by Travis at Iowa, a good deal is included besides exercises in writing and speaking and the ' unification of motor leads.' We are told that the treatment prescribed always includes physical hygiene, mental hygiene, and general speech exercises. There is, therefore, little or no evidence for ascribing the results to the neurological processes alone.

In my view, therefore, the benefits of these left-handed exercises could usually be secured by other tactics, without condemning the child to the many petty inconveniences that permanent left-handedness brings in its train. Accordingly, my general practice is this. With the occasional exception of those who show marked neurotic tendencies, I recommend that all left-handed children should be taught in the first instance to use the right hand, and taught from the earliest possible age. Special attention, however, must be paid to the methods adopted; and I would add that such precautions are particularly necessary in dealing with the dull.[1]

Practical Suggestions.—In school, as we have seen, the supreme difficulty for the left-handed pupil is right-handed writing: other modes of manual training are comparatively easy, and idiosyncrasies in other forms of manual work are not subject in the same degree to social comment and criticism. I shall, therefore, confine myself to the problem of teaching the left-hander to write. The difficulties of writing with an unskilled hand may be greatly minimized if the task is approached by gentle stages, and above all if it is begun at the earliest moment before counter-habits have been set up in the other hand. I recommend the following principles.

(1) First of all, let the change of training be as *unconscious* as possible. Say nothing whatever to the child about which is the proper hand to use. Carefully stage-manage the early occasions on which his hands are to be employed, so that the right hand will be employed naturally and automatically. Do not give him a succession of opportunities to practise his left hand, and then come down upon him for using the wrong one. At every stage, instil and

[1] It is often stated by those who deal with such cases at speech clinics that left-handed stutterers tend to be duller than right-handed stutterers. This might be due in part to the fact that left-handedness is commoner among the dull and the defective than among those of normal or supernormal intelligence. A preliminary statistical analysis of my data, however, strongly suggests that the correlation between left-handedness and stuttering is actually higher in dull and backward groups than in the normal; and, as already indicated, there can be little doubt that the child who is dull as well as left-handed finds it more of an effort to adapt himself to the tasks required of him.

practise the proper habit unawares, without the child knowing he is being watched or corrected.

There are many obvious devices by which this can be done. It may be achieved most readily if we recall the principle which, as I have already argued, is nature's own, and if, instead of leaving the left hand entirely idle, we attempt a division of labour between the one hand and the other. Let both hands be active together, and at first let them be active in much the same way. To begin with, for example, the child may be asked to beat time or make circles in the air with his two hands moving together simultaneously: actually the movements will be different—those of the one hand being, as it were, the complement to those of the other. Then he may be asked to take a piece of chalk in each hand, and, moving both hands simultaneously as before, to make symmetrical patterns on the board. Later, when the smaller muscles of the right hand have been practised to a sufficient degree of skill, the activities of the left may be gradually confined to its larger muscles and ultimately reduced to simple postural functions—holding and steadying the slate, the mill-board, the sheet of paper, or whatever object the right hand is required to work upon. All this should be done without the child himself realizing that he is being subjected to a special form of training or guessing what the secret purpose of the exercises may be.

The general principle may be illustrated as follows. Ask the child to draw circles or wavy lines on the board; but see that the board is covered with writing beforehand, and let him clean it first. The left-hander will naturally take the duster with his left. When he has cleaned the board, tell him to keep the duster, as he may want it. Since his left hand is engaged with the duster, almost inevitably he will pick up the chalk with his right; and so, for the first time, he spontaneously uses his right hand for drawing. When presently he discovers what has happened and tries to change hands, simply postpone the exercise without further comment. If this procedure is tactfully repeated again and again, a right-handed habit may eventually become fixed without the child ever being aware that he was originally tempted to use the wrong hand. The

ingenious teacher will be able to embody the same diplomatic principle in a hundred little exercises of this type.

(2) Before actually setting the child to write, employ plenty of *preliminary practice* of every conceivable kind—drawing large patterns on the blackboard, tracing letters in the air, feeling the shapes of sandpaper letters with the eyes blindfolded.

(3) For all such preliminary practice and even when he begins to write, let him start with *large movements first of all*—movements of the arm rather than movements of the fingers. This means that his earliest efforts will be made with enormous letters in the air or on the board: small letters with pen on paper will come much later.

(4) Finally, *leave the harder strokes till last.*[1] For the unskilled right hand the chief difficulties, it will be found, occur at three main points: (i) in making the lateral curves such as are required for many of the shorter letters—*c*, *o*, *a*, *s*, and the like; (ii) in the horizontal movement involved in continuous and cursive small-hand; and (iii) in forming light strokes directed upwards and inwards, *i.e.* obliquely from the bottom left-hand corner of the page towards the top right-hand corner: in ordinary writing these oblique strokes occur over and over again in commencing or in joining the several letters. The left-handed child, therefore, will find his task far easier if he is allowed to begin with big printed capitals, where there are few curves, and where most of the strokes consist of straight, downward lines. Later on he can proceed to print-script, where the horizontal strokes are few and the upward joining strokes are omitted altogether. The curling, circling, convoluted style of the regular round-hand copybook should never be put before him as a model. If eventually his strokes tend to to slope backwards (and backward-sloping writing is very common among the left-handed and left-eyed), do not be too eager to correct him.

Most of the stages to which these suggestions refer should be in theory completed in the infants' department: in the senior department the sole requirement should be simply to increase efficiency and speed by steady practice.

[1] Cf. footnote 1, p. 347.

All through, the left-handed child should unobtrusively be watched to see that such training sets up no conflict or worry: so soon as it does, the efforts should be relaxed. It will be in re-training those who have already formed a left-handed habit that this caution is most imperative—for example, in the bottom class of the upper school. Here, as we shall see later on,[1] it is by no means uncommon, particularly among the boys, to find left-handed children who show signs of stuttering and other mild nervous disorders about six months after their promotion. The trouble, as a rule, comes from the change in disciplinary methods. It is now, too, that the child begins to feel that he is peculiar and unusual: and, since in the senior department there is less time and opportunity for individual teaching and for individual methods, some rough and ready mode of correction has generally to be adopted. As a rule, if the child is taken slowly and quietly, and the above principles are applied, the nervous symptoms will clear up. If they do not, it will be wiser to let the child follow his natural bent and keep to his left-handed ways.

I may add that, even when it has been decided to allow the left-hander to use his left hand for writing, he will still require assistance. I have seen teachers going round a class, showing other pupils how to place the paper and hold the pen, but leaving the left-hander to discover these things entirely for himself. Actually he needs more help, not less, if he is to learn how to manage his left hand efficiently.[2] His paradoxical task is to produce with the left hand a style of writing evolved for the right. Abandoned to his own devices, he may tend to copy the posture of the rest of the children in the class—a method which, of course, will hinder rather than help his left-handed movements; or he may assume the position natural to a left-handed manipulation of the pen, and that in turn will very likely lead to so-called mirror writing. There is, however, no necessity to describe in detail the requisite adjustments: they will be evident to the teacher after a little reflection, particularly if he first tries the experiment of left-handed writing himself.[3]

[1] See below, p. 367. [2] Cf. Fig. 10B and footnote 1, p. 344.

[3] The teacher's main problem—whether to teach the left-handed child to

V. *Mirror-writing*

Definition.—A quaint peculiarity, found especially among backward and left-handed children, is reversed writing or 'mirror-script.'[1] By a mirror-writer I understand a child who writes two or more consecutive letters from right to left, in such a way that the forms of each and of the whole are reversed, like the imprint left on a blotting pad. The writing looks illegible until it is seen reflected in a mirror, or until the paper is held up to the light and viewed from the back.

Incidence.—In making a survey of a sample borough, I calculated that the number of mirror-writers so discovered amounted to about one in five hundred children.[2] The

write with the right hand—together with the prevailing views, are examined by Uhrbrock in a brief but instructive little monograph called 'What shall we do with the Left-handed Child?' *Cornell Rural School Leaflets*, XXIV, 1930, pp. 122–9. A more general examination of the subject from a practical standpoint will be found in Scheideman, *The Psychology of Exceptional Children* (Houghton Mifflin, 1931). A bibliography of 219 numbers on left-handedness and laterality has recently been published in the *Psychol. Bulletin*, XXX, 1933, pp. 133–42.

[1] This designation is a translation of the term first proposed by German writers, *Spiegelschrift*. The earliest description of it is to be found in the phrases used by the mathematician Fra Luce Pacioli in alluding to the handwriting of his friend and companion Leonardo da Vinci (1452–1519): 'Scrivesi allo rovescia e mancina . . . che non si posson leggere se non con lo spectro, ovvero guardando la carta del suo rovescio, contro allo luce . . . come fa il nostro Lionardo.' Apart from this, the earliest recorded case in medical literature is that of a left-handed epileptic girl. It was noticed that she wrote *laeva manu, ordine inverso, a dextra versus sinistram. Judaeorum more*: the observer adds *quae scripsisset legi non possunt nisi obversa speculo* (Rosinus Lentilius, *Miscellanea Medico-practica Tripartita*, 1698). The subject has given rise to much interest and a voluminous literature: Mohlman (*Training the Non-Preferred Hand*, pp. 223–30) gives a bibliography of 170 titles, and further references are added in Fuller's article on 'The Psychology and Physiology of Mirror-writing' (*Univ. California Publications in Psych.*, II, pp. 199 *et seq.*). Of articles more easily accessible to the British reader perhaps the best is the recent paper by Dr. James Kerr: 'Left-handedness and Mirror-writing' (*School Hygiene*, 1920, Feb. and May). Compare also Judd, *Mirror-writing*, Munro, *Cyclopædia of Education*, IV, 1913, pp. 252 *et seq.*, and Critchley, *Mirror-writing* (in the Psyche Miniature Series, 1928).

[2] Beeley, by a questionnaire addressed to teachers in Chicago, discovered only one mirror-writer in every 2,500 children—practically all the mirror-

majority of instances were found between the ages of five and nine. 93 per cent. were left-handed ; and 78 per cent. wrote the mirror-script with the left hand. Mirror-script appears most frequently when the child passes from the scribbling stage to the stage of formal writing. Unless kept alive by practice in this form, the tendency quickly dies out as the child grows older. In adults it is comparatively rare.[1] Among the four hundred backward cases studied in London I found seventeen examples of occasional mirror-writing—seven boys and ten girls. Six (all girls but one) were under the age of eight ; and these were the only instances in which more than a few sporadic letters and letter-groups were affected. Among the defectives, 7·1 per cent. of the boys and 13·6 per cent. of the girls showed a persistent tendency to mirror-writing in certain words, letters, or figures.[2]

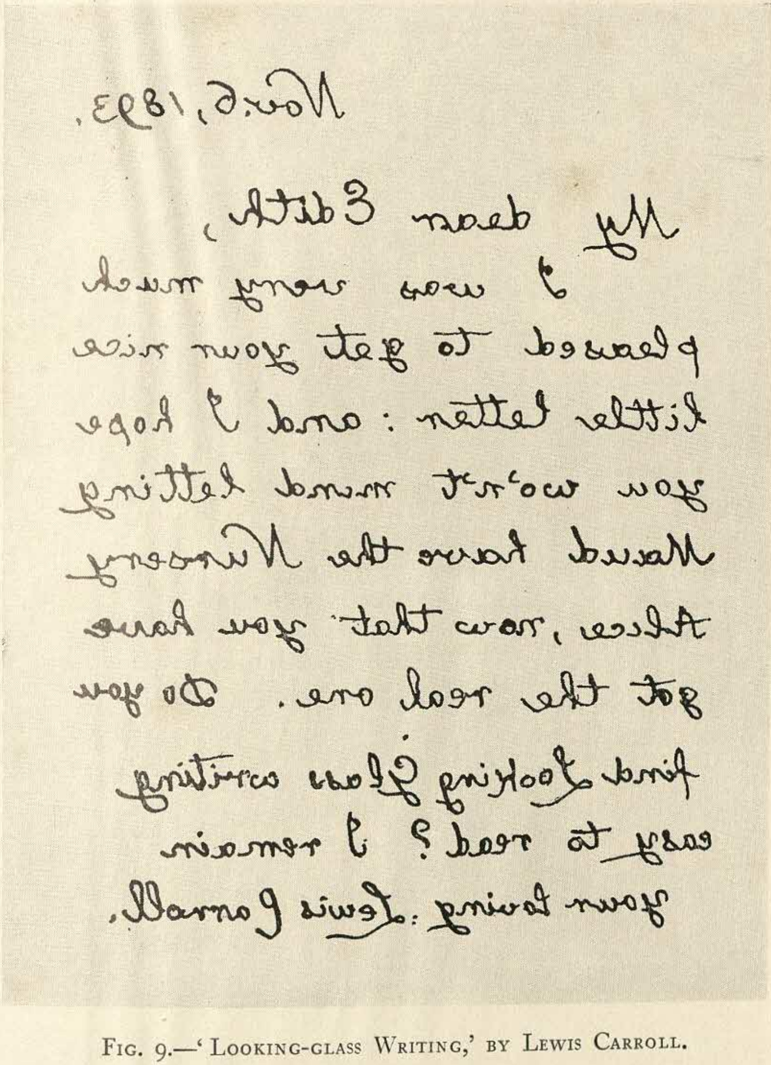
Mirror-script is by no means confined to the subnormal, though subnormality may usually be inferred from its persistence.[3] As a transitory phase among normal children

writers using the left hand (*An Experimental Study of Left-handedness*, 1918). Gordon, by actual tests of writing, found as many as one in every two hundred—' nearly all left-handed children who write with the *right* hand ' (*Brain*, 1921, ' Left-handedness and Mirror-Writing, especially among Defective Children ').

[1] Actual experiment will show that there is a great deal of difference in the ease with which adults can perform mirror-writing. The left-handed find it easier. After a lecture on the subject, a Yorkshire teacher in my audience came forward, and wrote on the blackboard with surprising speed any phrase called out to him, in one of four different ways—normal or mirrored, upside down, or simultaneously mirrored and inverted : he concluded by writing short phrases with both hands at once, the one hand always mirroring what the other was doing. He claimed to be ambidextrous ; but a few tests and questions indicated that he was apparently a case of inherited left-handedness, corrected during early years.

[2] Similar figures from normal and abnormal children are noted by foreign observers like Lochte and Lange (see *L'éducation moderne*, 1908). Figures are not usually given for the separate sexes. June Downey, however, states that she discovered no sex-difference (' On the Reading and Writing of Mirror Script,' *Psych. Rev.*, XXI, 1914, pp. 408 *et seq.*).

[3] Lewis Carroll often used to write to his young friends what he called ' looking-glass letters.' (See Fig. 9, reproduced by kind permission of the publishers from Collingwood's *Life and Letters of Lewis Carroll*. I have omitted about twelve lines of manuscript before the last sentence.) His



Nov. 6, 1893.

My dear Edith,
I was very much pleased to get your nice little letter: and I hope you won't mind letting Maud have the Nursery Alice, now that you have got the real one. Do you find Looking-Glass writing easy to read? I remain your loving Lewis Carroll.

FIG. 9.—'LOOKING-GLASS WRITING,' BY LEWIS CARROLL.

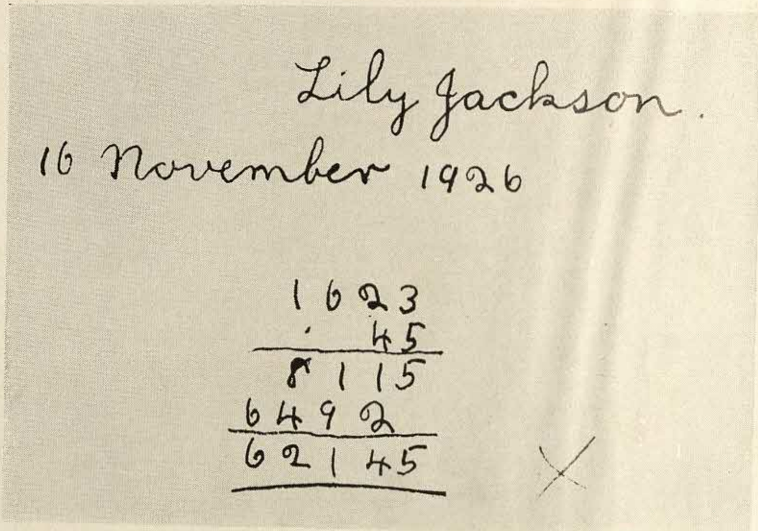


FIG. 10A.—ORDINARY WRITING OF BACKWARD GIRL.
(Written with right hand.)

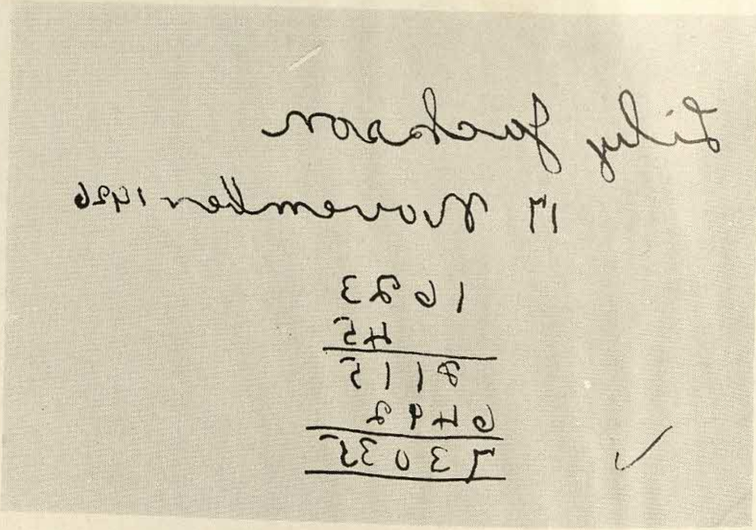


FIG. 10B.—SPONTANEOUS MIRROR-WRITING BY SAME GIRL.
(Written with left hand; right hand temporarily incapacitated.)

Chronological age, $11\frac{8}{12}$; mental age, 10·0; educational age, 9·5
congenitally left-handed.

in the infants' school, reversals in writing are far commoner than is ordinarily realized. There are few who, when first beginning to print or write, do not at times reverse isolated letters: b and d, q and p, which form mirror-images of one another, and N, S, Z, which to the un-analytical eye appear symmetrical but yet in fact are not (though eleven of the capital letters actually are)—these are the characters most frequently turned round. This, however, is rather different from the tendency to write, or to start writing, whole words or sentences backwards. With normal children, whether confined to one or two letters or influencing the writing as a whole, the tendency as a rule lasts only for a few days or at most for a few weeks. Teachers report that the spontaneous dropping of such peculiarities, like the spontaneous adoption of the right hand for writing and for drawing, in preference to the left or to either indifferently, often coincides with a marked acceleration in general progress both among young normals and among defectives.

Experiment will show that the inveterate mirror-writer is almost always able to read his own writing, though it may

mirror-script is exceedingly fluent; and since he is known to have stammered, he might be claimed by some as a probable instance of an original left-handedness in a person of nervous temperament who had unfortunately been taught to use his right hand. But perhaps the most notable example of mirror-script among men of genius is to be discovered in the curious, cryptic-looking notes, left to posterity by Leonardo da Vinci. I have already quoted Fra Pacioli's description of them. The manuscripts, numbering more than 5,000 pages, are (as Vasari observed) nearly all written from right to left. Any visitor to the British Museum may observe this peculiarity if he pauses over the Arundel MSS. in Case XI of the Manuscript Saloon. (I have reproduced a facsimile, together with samples from various children, in my volume on *Mental and Scholastic Tests*, p. 314.) Reflected in a glass the writings can be readily deciphered. The peculiarity is usually put down to his well-known love of mystification—for the MSS. are full of rebuses, and many place-names are spelt backwards. However, the penstrokes in the sketches that accompany the notes indicate that he used his left hand. It is significant that Cardinal Luis of Aragon, after a visit to him at Cloux, observed that Leonardo, then an old man of sixty-five, was afflicted with a paralysis of the right hand. But practically all the well-authenticated instances of his handwriting are written in this way, some dating from the age of twenty. And, according to Fra Sabba da Castiglione, it would appear that Leonardo had always been left-handed.

present insuperable difficulties to his teacher. Generally, too, he can read the mirror-writing of others, especially if their style of calligraphy does not depart very greatly from his own. Print mirrored in a glass, or typescript reversed by applying carbon-paper to the back of the sheet, he is usually unable to decipher.

Causes.—Mirror-writing can readily be provoked by artificial means. Ask the children to begin from the right-hand margin of the page, or to write with the left hand; and many will, spontaneously and unconsciously, produce clear and fluent mirror-script, as though all their lives they had written in that way. With this experiment the words and letters that are reversed with greatest frequency and ease are those of the child's own name: these, of course, involve movements which are the earliest to be learnt and therefore the most firmly and most thoroughly fixed. In much the same way a similar reversal will appear after a sudden change of hands, due, not to a passing request, but to some accident which puts the usual hand out of action. A girl of eleven whom I was testing sprained her right wrist: the next day all her dictation and all her sums were written and worked with the left hand from right to left[1] (see Figs. 10A and 10B). But by no means every child displays these effects: with many not a single letter is reversed. It is therefore instructive to test the two groups, and see if any further characteristics mark those who are liable to make reversals. Two points stand out. First, as I have already implied, most of the habitual mirror-writers, and a large proportion of those in whom spontaneous mirror-writing can be artificially induced, prove, when carefully tested, to be in some degree left-handed; secondly, nearly all of them appear to be (if such loose descriptions may be permitted) motor-minded rather than eye-minded: they seem to guide their fingers more by the feel of the movements made than by the look of the letters produced.

[1] It will be observed that, when she writes with the right hand, she adds in the direction in which she writes, and so produces an incorrect total. When she writes mirror-wise, she still adds in her habitual direction, namely, from left to right, so that now the total is correct. Note, too, the peculiar and varying angle at which the pen is held by the left hand.

This suggests the explanation. As the mirror-writer forms his letters, the correctness of the particular shapes and the wrongness of the general direction seem alike attributable to the fact that the nervous centres for motor control and the nervous centres for visual control may at times function in total independence. With nearly all of us, immediately an action becomes completely automatic, it tends to slip away from the control of the attentive eye, and to be left to the half-unconscious guidance of the muscle-sense. For most people, however, writing has not become quite so mechanical as this ; we usually fix our eyes on what we write, if only to keep the writing on the line and within the page. But there are wide individual differences. Some cannot shave or do their hair except with the aid of a mirror ; others rely far less upon sight : and a few can write perfectly, and even draw a pig with its eye correctly placed, with their own eyes blindfolded. The differing degrees of visual control and motor control may readily be observed if a number of persons are asked each to sign his name on a piece of paper held against his forehead, or against the under surface of the table : nearly always those who are strong visualizers will be found to have written mirror-wise ; those who trust solely to motor habits will generally write in the normal fashion. The young mirror-writer belongs almost invariably to this so-called motor type. At any rate, while he is mirror-writing, his hand as it moves is steered by its own muscle-sense, unchecked by the eye that is supposed to be watching it. By force of habit, the successive movements—so far as their varying changes of direction, relatively to one another, are concerned—are executed correctly ; but the absolute orientation of the whole result upon the page is visibly wrong. Yet the child seems scarcely to perceive that he has produced anything out of the common.

This explanation, however, still leaves one or two minor points obscure. First of all, why is it that lateral reversals are so much commoner than vertical—why is mirror-script comparatively frequent, and inverted script so rare ? Clearly the lateral changes involved in mirror-writing must appear much slighter than the up-and-down reversals of the in-

verted form: they must appear much slighter both while the movements themselves are being performed and felt, and also when their results are afterwards reviewed by the eye.

Consider the performance of the movements, to begin with. The human body is constructed on a symmetrical plan: and the symmetry affects not only its structure, but also its functions and its actions.[1] Hence, to a large extent the movements that go most easily together are symmetrical and not similar movements; presumably such movements are governed by the same nervous centres. Draw on the blackboard two circles or two capital S's or two coiling arabesques, using both hands at once: it will be almost impossible to make identical figures simultaneously with the right and with the left. But, if the left hand mirrors what the right is doing, the double movement becomes easy and natural. Usually, if the arms are free, the right hand will move clockwise, and the left counter-clockwise. The tendency is most clearly seen if a piece of cardboard is held edgeways against the chest (much as the drummer carries the big drum), and the two hands then write the same word simultaneously on opposite sides of the same board.

In writing with the right hand, the natural tendency is to begin at the left-hand margin and proceed towards the right: this, in fact, is the direction which English handwriting follows. The reasons are clear: first of all, it is

[1] The symmetry is at times observable even in reflex action. Indeed, one early physiologist, in generalizing the phenomena observed when nervous impulses spread from one part of the body to another, has formulated (among other laws) a 'law of bilateral symmetry in reflex action': 'when the change produced in the central organ by the excitation of a sensory nerve has already evoked a unilateral reflex, then, if it spreads farther, it excites in the contralateral half of the cord only those motor mechanisms which are symmetrical with those already excited in the homonymous half of the cord' (Pflüger, *Die Sensorische Funktionen des Rückenmarkes*, 1853). His 'laws' have been generally accepted. Sherrington, however, points out that this statement 'although true of a number of instances, fails to conform with fact in many, even perhaps the majority' (*The Integrative Action of the Nervous System*, 1906, p. 162). It is, for example, less true of leg-movement than of arm-movement: walking (unlike jumping) does not proceed by symmetrical movements of the two legs simultaneously. A human being who made his way down the street, like a sparrow, with both legs hopping at once, would assuredly startle the beholders.

easier to pull the pen than to push it ; and, secondly, the hand in moving thus does not obstruct the view of what it has just written. When the left hand holds the pen, the reverse direction is more natural ; to work from the left-hand margin towards the right would now involve a clumsy shove. With both hands abduction is easier than adduction ; and with either hand the easiest stroke of all is a long, light, rapid line drawn obliquely outwards and upwards. With the right hand, this means moving away from the bottom left-hand corner and upwards to the top right-hand corner : and, as we have already noted, most letters, in ordinary joined handwriting, begin with such a stroke. With the left hand, such a stroke is the most difficult of all ; hence, if he is not exercising careful attention and control, the left-hander tends naturally to substitute a movement upwards towards the left and so begins his letters with a reversed or backward movement.[1]

[1] It will be instructive to the teacher to observe how the commoner strokes in handwriting consist in the main of the strokes that are easiest for the right-handed person. A consideration of the detailed principles involved will prove exceedingly helpful in understanding the difficulties, not only of the mirror-writer, but also of the left-handed generally. The direction of the easier strokes depends on whether the stroke is light and rapid or heavy and short. A heavy *upward* stroke is difficult with the pencil and all but impossible with the pen. Thus, when the stroke is made downwards and inwards, *i.e.* by adduction instead of abduction, the natural tendency is to go more slowly, to press more heavily, and to make a shorter movement. With straight strokes the easiest for the right hand are (i) a short, heavy, downward stroke, moving almost but not quite vertically downwards, and a little towards the left, and (ii) the long, light, slanting upward stroke just described, which moves up and to the right. The smaller letters of German script are largely made up of these two strokes. These straight strokes may be made with arm movements only ; the curvilinear strokes require the co-operation of the wrist. (With the practised writer the finer movements of the fingers enter into both.) With curved strokes the easiest are (iii) a short, heavy, downward curve, made counter-clockwise and bending back like a letter *c* : a ' concave arcade ' (inverted arches) made of a series of *u*'s (usually looped like *e*'s) is the easiest of all prolonged curvilinear movements, and much rapid handwriting tends to degenerate into this form : we all know persons whose *m*'s and *n*'s look like *u*'s ; (it will be observed that most of our curved letters contain this stroke—*e.g.* *a*, *c*, *d*, *e*, *i*, *l*, *o*, *t*, *u*, *w*, and the circular parts of *g* and *q* ; *ſ* and *S* begin with this stroke and end with the following) ; (iv) a long, light stroke, bent in the opposite direction, *i.e.* made clockwise, beginning a little heavily but tending to curve widely away to the left, like

It is instructive to note that, when a left-handed child draws a man's profile or a moving object like a railway train, he nearly always makes it face, not towards the left, as the right-handed child does, but towards the right. As anyone may prove for himself, by outlining a forehead, nose, and mouth, first with the right hand, then with the left, this principle yields the easiest movement in both cases. Further, in fitting on the hinder and less important parts, the hand does not obscure what has already been drawn. Finally, the result corresponds with the child's habitual view of his toy animals and trains as he drags them along with his more active hand.

In writing, the whole pattern of movements—the *Gestalt* (to borrow a term from a contemporary school of psychology)—having been learnt by one limb or by one set of muscles is learnt once for all. Whether penned on paper with my right hand, or chalked in huge characters on the blackboard with my right arm, or scrawled on the floor with a pencil held between the toes of my right foot, my signature bears always the same characteristic conformation—although until this day I never tried writing with my feet before. But when I use the limbs on the opposite side of my body, the likeness disappears, and a principle of symmetry or reflection rules in its place. A stroke made from right to left with my left hand corresponds with a stroke made from

the large tails sometimes given to *g*'s, *j*'s, *y*'s, and *z*'s, and often seen in flourishes beneath signatures; and (v) a still larger and lighter stroke, also curving clockwise, moving up and over to the right, usually too wide for letters, but often seen in large flourishes over the signature: the movement may end in a heavy stroke by curving down, as in the first stroke of the letter *m*; but this is a somewhat harder and rarer movement: owing to its difficulty there is a natural tendency for it to be finished off with a reversed curve, as though the wrist compensated for the first difficult movement by springing back like a released spring; the result is the 'pothook' which completes the *h*, the *m*, and the *n*: when repeated, this stroke tends to degenerate into a 'convex arcade'—a succession of arches made by a series of unfinished m's with looped feet. It may be noted that the tendency towards the small concave and the large convex arcades is very conspicuous in German script: both are seen in the capital *M*. I may add that Miss Richardson's excellent method of teaching handwriting—a method particularly successful with the backward—begins by practising the child in the formation of these easy arcades.

left to right with my right hand. Abduction with the right corresponds to abduction with the left. But, though both movements are physiologically similar, they are not similar in their results : they take the limbs in opposite directions. Both, however, are movements away from my trunk ; and for me, therefore, they seem movements in the same direction, though an onlooker rightly calls them symmetrical and reversed. Hence, the apparent reversal of pattern when I transfer a scheme learnt with the right hand to the left is a reversal for an independent eye, but not really a reversal for my own feelings of movement. Thus, from the standpoint of motor control, it entails no real exception to the rule that a pattern as learnt by one limb may be transferred automatically in its original form to any other.

The child, then, in learning to write from left to right with his right hand is, as it were, unconsciously learning to write from right to left with his left hand : that, at least, is the effect produced when he tries to execute, mechanically and without thought or visual guidance, the same pattern of movements with his left that he has already acquired with his right. With the left hand, therefore, mirror-writing is a natural tendency to which we are all more or less liable ; and our liability is greater, the more we are guided by the motor sense and the less we rely on vision. It is found most frequently of all among left-handed persons, because with them the left hand can execute fine movements with the greatest facility, and consequently depends least on the guidance of the eye.

How is it, then, that mirror-writing is occasionally produced with the right hand ? The answer appears to be that it is a reversed transference from the left hand to the right instead of from the right hand to the left. As the case-histories show, in the vast majority of instances it arises as a secondary result of previous efforts to achieve normal writing (running from left to right) with the left hand.[1]

[1] Sometimes it would seem that, even when the movement-patterns learnt are not actually transferred from one hand to the other, a mere difference in the position from which the same hand starts may be sufficient to unwind the scheme of movements in the opposite direction. If, from accident or carelessness, a child begins the top stroke of *Z* or *F* on the bottom line (instead

Why, then, does not every left-handed child turn into an habitual mirror-writer? The obvious answer is that most of them quickly learn to correct their writing by watching what they write. And this leads us to examine the second main factor in the process—the influence of vision. For the eye, as well as for the limbs, lateral reversals are less conspicuous than vertical; and some persons are slower to note the difference than others.[1] The fact is that the eye at the outset identifies shape more readily than position or orientation. In practical life, shape is more vital. We have to recognize the table and the chair whether we see them from the front or from the back. We have to recognize our caps and our clothes, our knives and our forks, even when they lie the wrong way round. Draw a sloping crescent on the board; ask the class to look at it for half a minute, and then to copy it from memory. Nearly all will get the form right; but few will get the position right. Even if the figure is left on the board, and they gaze at it as they draw, the copy may still be reversed, or inverted, or both; and rarely will the youngest of the copyists perceive any mistake. Similarly, in reproducing letters, the tiny child is satisfied if he fashions the shapes correctly, and does not at first trouble whether each letter is properly oriented: an isolated number, such as 2 or 6, he may draw backwards, sideways, or even upside down.

But when he comes to setting letters side by side to make a word, he has to consider, not only the shapes of the component letters, but the shape of the word as a whole. This

of well above the line, as he would have done had he pictured the completed whole before commencing), or if he makes the stroke backwards instead of forwards, then the subsequent movements of his pencil may be determined by their direction relative to this first movement, not by a visualized intention to orient the total shape the right way upon the page. As a rule, however, this cause seldom leads to the reversal of more than one or two letters—a single word at most. It is the chief explanation of such occasional reversals as are found with almost every child when he first begins to write.

[1] Cf. Stern, 'Uber verlagerte Raumformen,' *Zeitschr. f. Ang. Psych.*, II, 1909, pp. 512 *et seq.* At an earlier age even vertical reversal, *i.e.* inversion, may pass unnoticed. Between the ages of 1½ and 3½ children are singularly indifferent to the position of drawings. They may enjoy looking at a picture-book upside down almost as much as the right way up, and will recognize a 'gee-gee' or a 'puff-puff' even when the legs or wheels are in the air.

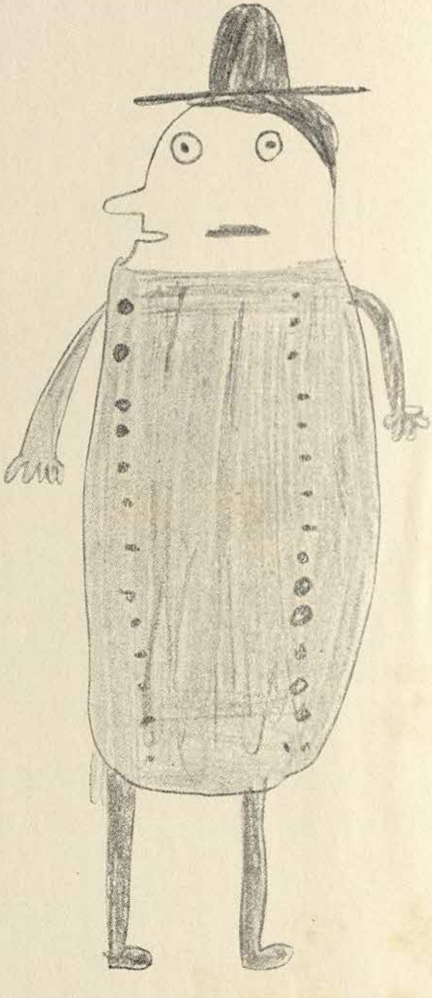


Fig. 11.—Drawing by Backward Girl.

Chronological age, $7\frac{10}{12}$; mental age, 5·6; educational age, 5·0; congenitally left-handed; draws and writes with right hand.

means that, when writing the initial letter, he has implicitly to visualize the remainder. The orientation of each now becomes important, because of its relation to the rest. Still, even now it is easy to overlook lateral reversals, though inverted forms may be no longer mistaken for the correct. In everyday orientation, lateral directions—right and left, East and West—are always more readily confused than vertical directions (or what we loosely think of as vertical)—up and down in space, forward and backward on the desk, and North and South on the map. Show a Londoner a photograph of the Houses of Parliament in which the print has been taken from the wrong side of the negative: most will recognize the scene; few will notice the transposition; but all would turn the picture round if handed to them upside down.

A still more instructive instance of this confusion is seen in a type of drawing occasionally produced by young or backward children and generally known as 'mixed profiles.' In an earlier work I have noted how nearly 70 per cent. of the human figures, drawn by children at the age of 6, are shown full face, and how, by the age of 11, nearly 70 per cent. are drawn in profile, facing (with right-handed children) to the left.[1] But all the parts of the body do not turn at the same stage or even in the same direction. Hence, during the transition, the drawing may for a while show incompatible aspects incongruously combined. The face may turn to the left, the feet perhaps to the right, while the trunk—and sometimes the eyes and mouth as well—are still displayed in full view (see Fig. 11). A child of normal intelligence soon perceives the inconsistency; but the dull often adhere to the same hybrid representation for a year or more. And, if my statistics can be trusted, the left-handed, especially those who have recently been required to write and draw with the right hand, or who are given to mirror-writing, seem more prone to these confusions. Much the same incongruities are to be seen in the efforts of primitive man; they appear in early Greek sculpture, and

[1] *Mental and Scholastic Tests*, p. 321. Wile and Wilson are quite wrong in inferring that prehistoric artists must have been left-handed because they made their profiles face to the left (*loc. cit. inf.*, p. 14).

persist in Egyptian and Assyrian sculpture even down to the latest periods : here the head is almost always seen in profile, but the eye as in full face ; the shoulders and body are seen from the front, and then, by a sudden twist, the legs and feet are drawn in profile.[1]

The lack of consistency arises from the fact that the child, like the primitive artist, disregards orientation and concentrates solely on shape : he thinks of each separate part as seen in its most characteristic aspect, that is, as a rule, from its broadest side. He draws a foot as a foot—as a typical foot, without considering the effect of his own position on what may be visible from where he stands, just as he sees a chair as a chair, not as a chair facing this way or that. The teacher who knows a little physiology is apt to infer that, because the retinal image of the chair is flat, therefore to begin with the child sees the chair in the flat, and only constructs a tridimensional chair by fusing the various aspects. This is erroneous. There is now little doubt that from the first the chair is seen stereoscopically as a solid object out there in tridimensional space. It is not till a late sophisticated stage that the more thoughtful and observant child slowly comes to realize that, in order to obtain a convincing representation of a three-dimensional figure on a two-dimensional sheet of paper, he must imagine himself fixed at one point of view, and draw the whole object and its several parts consistently from that.

The eye, therefore, needs to be progressively educated to observe orientation and lateral direction as well as shape. So difficult is this process, and so dependent on intelligence, that tests of orientation have been successfully used to measure mental development.

But the eye has not merely to observe : it has to learn to guide the hand. Muscular movements are primarily under the control of the muscle-sense—that sixth sense resident in the muscles themselves. It is only secondarily that they come under the supervision of the eye. Eye-and-hand co-ordination is a process of double functioning that is never acquired without some difficulty. Now, as we shall learn in a later chapter, many young children, particularly among the dull

[1] Cf. E. Loewy, *The Rendering of Nature in Early Greek Art* (1907).

and backward, tend to be motor-minded rather than eye-minded; with them, in particular, actions are regulated much more by muscle-sensations and movement-patterns, and much less by ocular analysis or visualized shape. For this propensity there are definite tests; and, so far as possible, I have applied them to most of the young mirror-writers whom I have examined. The results fully bore out the suspicion that most of them belonged to the so-called motor type. With adults, as we shall find, the motor type is apparently not so common. With them eye dominates more easily over muscle-sense. As a rule, they have come to rely almost inevitably on visual guidance wherever the movement has to be expressly superintended: hence an adult finds it easier to write mirror-wise when he keeps his eyes closed.[1]

The trouble which the mirror-writer has in exercising this ocular control is plainly displayed when he attempts the test of mirror-drawing—*i.e.* drawing with hand and paper visible only from their reflection in an upright mirror.[2] The experiment throws a good deal of light on the process of mirror-writing, where, of course, no actual mirror is used. I have carried out this test with a large number of boys and girls, including some twenty mirror-writers. The results are of great interest to the theoretical psychologist; and the general reader will forgive me if I briefly summarize them here.

It might be supposed that mirror-writers would make good mirror-drawers. This seems true of the older, but not of the younger children. In mirror-drawing, the directions that have to be reversed are the sagittal

[1] It is the slight difference of ease in acquiring motor skill that seems chiefly to explain the apparent sex-difference. Although left-handedness is commoner among boys, mirror-writing is commoner among girls. Now girls are quicker at acquiring fine skilled movements with the fingers and hands; and with them such movements are less controlled by sight: they learn type-writing and piano-playing by the 'touch method' more readily than boys; and sewing, knitting, crocheting, and the like, with them quickly become automatic. Older girls, too, are superior in the mirror-drawing tests; and, though this is in part attributable to greater experience with the looking-glass, introspections show that in the test many actually rely but little on what they see in the mirror. They adopt the second of the methods described in the following paragraph.

[2] See Burt, *Brit. J. Psychol.*, *loc. cit. sup.*, pp. 145–9; and below, p. 503.

or 'vertical' movements, not, as in mirror-writing, the lateral. There are two ways of learning to accomplish the change. The first is to watch carefully the movements of the pencil in the looking-glass, and control the hand-movements accordingly by the eye. The second is to ignore altogether what the eye sees in the glass, and to think only of the feel of the movements themselves: the experimenter says to himself in effect, 'I have to bring my hand down towards me in such and such a direction, whether or not I see my hand moving in the opposite direction in the mirror.' With many persons this purely kinæsthetic control will greatly help in finding the right general directions, though the finer adjustments (as in tracing a pointed star) still need the assistance of the eye. According to the results of my own experiments, the former method—that of purely visual control—proves to be the method chiefly adopted by the younger children; the latter—kinæsthetic control—by older and brighter children, particularly the girls, and by most of the more intelligent adults. Now when the younger mirror-writers are set to do mirror-drawing, they show great difficulties in controlling their hand-movements by vision. At a later age, just because they rely so little on what they see, they often achieve a remarkable success: in these cases their introspections suggest that their quickness is largely due to the ease with which they can ignore all ocular perception of what their hand is up to, and trust mainly to their muscle-sense.

The varying influence of visual control is also well seen in the learning of a foreign alphabet, where some of the characters are new and others are not. Small boys in the preparatory school, set to copy the Greek alphabet, not infrequently reverse those letters with which their hand is familiar, such as Z or N, but they seldom reverse the strange letters like Γ or Σ. In the latter case, just because of the novelty, the learner is forced to look at the copy, and his hand has to be piloted by the eye; in the former case, the hand thinks it knows what to do, and the visible model is neglected. Even when there are no actual reversals, it is still the new letters that are most elegantly shaped—the φ, θ, π—while the old ones are carelessly scribbled, much as in

speaking a strange tongue the unfamiliar gutturals or nasals will be most scrupulously articulated, while vowels and consonants approximating to the English will be given the easiest and most automatic pronunciation without any self-correction by ear.

The bearing of all this on the training of the less intelligent will be obvious. It is with the dull and the defective more particularly that this higher and more sophisticated control of the finger-muscles by an attentive eye, instead of by their own intrinsic muscle-sense, proves difficult to acquire. Hence it is with the dull and defective that mirror-writing is most likely to persist. These are just the individuals in whom sustained attention is lacking and for whom complex sensori-motor co-ordinations are hard to acquire. If these explanations are accepted, there will no longer be any need to account for the defective's reversed or inverted letters by postulating some 'defect or lesion in the writing centre of the brain.' Such a defect would presumably be incurable; whereas trial will quickly show that, even in the dullest defective, the peculiarity can generally be rectified by appropriate methods of training.[1]

[1] In the past, medical writers have usually considered mirror-writing to be a pathological phenomenon. Hence mirror-writing in the mentally deficient has been interpreted in the light of theories suggested by the occurrence of mirror-writing in cases of hemiplegia and aphasia: for example, it has been declared that the facts can be explained only by postulating two centres for writing, one in the right hemisphere of the brain as well as one in the left. This seems to be an instance of what I am tempted to term the 'pathologists' fallacy.' The doctor's observations are confined to pathological cases, and seldom extend to the normal; accordingly, he tends to attribute all his patients' peculiarities to their pathological condition, quite unaware that the same peculiarities may be found among the normal. According to the account I have put forward above, the reversals depend not so much upon a supposed symmetry in the functions of the brain or its parts, but rather upon the symmetrical structure and functioning of the body as a whole. If I am right, mirror-writing is a normal consequence of the natural tendencies of the left hand in motion. All the cases cited by Buchwald (the earliest authority to lend support to the pathological interpretation) were hemiplegics who were paralysed on the right side and wrote mirror-wise with the left hand (*Berlin Klin. Woch.*, XV, 1878, pp. 6 *et seq.*). But the most extensive set of cases is that of C. Fraenkel, who describes 79 hemiplegic patients, among whom 24 wrote mirror-wise (*Archiv. f. Psych.*, XLV, 1908, pp. 1275 *et seq.*). On examining his data I find that, of the 79, as many as

There is, I think, one other factor influencing the emergence or non-emergence of mirror-writing among the left-handed. This is the readiness of the child himself to give the extra effort that is required in order to inhibit the more natural tendencies and to fix what is (for the left-hander) an unnatural style of writing. Hence, whatever weakens the power of control—for example, temporary fatigue or chronic neurasthenia—is apt to induce mirror-writing in the left-handed child. Many, having conquered it, will relapse into it when tired or irritable.[1] Mirror-writing is found with special frequency, not only in the motor-minded and dull, but also in the neurotic ; and often the case-histories show that the first occurrence or the

58 were paralysed on the right side, and therefore did their writing with the left hand : of these rather more than one-third (21) wrote mirror-wise. The three other mirror-writers were patients whose left side was affected ; but we are told that these three were exceptional in that they wrote with the paralytic hand, that is, once again with the left.

Now, as we have seen, it is easy by a simple experiment to observe what happens when a child's right arm is rendered inactive *without any lesion of the brain.* It will be found that a large proportion, particularly the young, the dull, and those of a motor type, write mirror-wise. Accordingly I am led to infer that the primary cause of the mirror-writing in the hemiplegics was not the fact that the brain was damaged, but simply the fact that they were obliged to write with the left hand. The slightly greater frequency of mirror-writing in cases of mental deficiency, aphasia, hemiplegia, and the like, is, in my view, to be explained not by the destruction of specific cerebral centres, but rather by the general lowering of attention and vigilance which accompanies these abnormal states : the motor mechanisms are consequently freer to operate automatically without active visual control. Mirror-writing is very liable to arise in any state of lowered attention—*e.g.* under hypnosis, during intoxication, in mediumistic trances, and during hysterical dissociation generally.

[1] A left-handed teacher informs me that she has got into the way of writing her evening diary entirely in mirror-script. At first, she told herself, this was for extra privacy : on reflection, however, she realized that this was a superficial afterthought, a rationalization, as the psycho-analyst would say, and that the true reason was fatigue. When she was weary—and, being of a neurasthenic type, she was nearly always weary in the evening—she relapsed into what had originally been a childish habit. Leonardo's manuscripts, it has been suggested, may have been written with the left hand to relieve an overworked right hand, just as he is said to have frequently changed hands when painting ; but it is equally conceivable that, being of an eccentric turn, he delighted in the feat for its own sake—a motive occasionally found in brighter children.

recurrence of mirror-writing in the small child was observed during some passing emotional crisis or during some disturbance of nervous health. Neurotic individuals, and those of a self-assertive type, disposed to stubborn obsessions and compulsions, are, as we have seen, by no means uncommon among the left-handed. They are intolerant of social criticism, and react against social conventions. Anything, therefore, that brings this self-willed attitude to the fore, while the child is learning to write, is likely to keep alive the tendency towards a contrary fashion in writing, or at any rate to remove the effort and self-control that might otherwise prevent its appearance or fixation.

I have noted several instances in which mirror-writing seemed to run in families. At one school, for example, I found two young brothers who amused themselves by writing to each other scurrilous notes in what they described as a 'secret code': their secret code was simply mirror-script. A German writer has described how a father and son used to correspond with each other in mirror-script, when the latter was absent for military service.[1] Such cases by themselves can hardly be cited as evidence of an inherited tendency, since one writer may merely have borrowed the idea from the other. Occasionally, the different ages of the two writers render the likelihood of borrowing rather small, and in a few instances the two relatives have neither seen nor corresponded with each other. But, unless we assume the inheritance of acquired characteristics, we cannot suppose that writing tendencies as such are transmitted from parents to children. In nine instances that I have been able to investigate in detail, the results have shown that the members of the family who wrote mirror-wise were left-handed; and I conclude that it was primarily the left-handedness that was inherited, together perhaps with a weakness of visual as distinct from muscular control.[2]

[1] Stier, *Linkshandigkeit*, p. 69.

[2] Just as I believe a study of the speech defects and mispronunciations to which the young and the backward are liable may throw light on the phonetic principles that underlie the evolution of language (cf. App. IV.) so I believe a study of the peculiarities of their handwriting may throw light on the evolution of handwriting among relatively primitive peoples. Why the earliest known writing should apparently have been sinistrad, why

Treatment.—The remedy is clear. It is simply to train the child to trust more to his eyes, and, so far as possible, to visualize beforehand what he is about to produce. Some teachers claim that the child is helped if he is encouraged to watch other children writing. In any case, for a while it will be wise not to let the child write spontaneously, and to allow him only to write slowly and carefully from a copy. If it is found that he gives his copy but a single glance, and then tries to reproduce the form from general impression, he should be required to make his version immediately below the model, or even at first to trace it on a semi-transparent slate or paper.

Let him begin by practising isolated letters, repeating them in a running series—' pppp.' So far as possible, each single letter should be made without taking the pencil from the page. If the pencil is removed when the letter is only half finished, the child often gets singularly confused as to where he is to start the remaining portion ; for example, if ' p ' is divided into a vertical stroke and a semicircle, he will often commence the semicircle at the bottom of the vertical stroke or on the left instead of at the top and to the right. On the other hand, particularly if the child is writing with his left hand, the difficult upward line with which most letters commence should be omitted, at any rate at the beginning of words : as we have seen, it is this stroke, more than any other, that starts the child mirroring the direction of his script.

Here as elsewhere, however, prevention is better than cure ; and the habit should never be suffered to take root in the first instance. Among normal children the tendencies

later on, by writing the sinistrad script mirror-wise, dextrad writing should have been produced, and why the reversal should have taken place among some races (*e.g.* the Greek) and not among others (*e.g.* the Semitic)—these are questions to which epigraphists have devoted little attention. Taylor, for example, is content to assume that the dextrad direction is ' the more natural direction,' and leaves the ' sinistrad direction of primitive picture writing ' unexplained (cf. *History of the Alphabet*, 1899, I, p. 179). Later writers have examined the historical facts in greater detail, but have rarely ventured on a psychological interpretation. The explanation of mirror-writing given above does much to elucidate these evolutionary problems, and thereby is itself to some extent confirmed. But a full discussion of these remoter inferences must be postponed to another occasion.

are usually transitory, and seldom get fixed. But all left-handers, especially the dull, should be closely watched from the outset, when first learning to write ; and, if ever a reversal appears in forming any particular letter, that letter should be practised in isolation until the eye recognizes its shape unhesitatingly and the hand automatically makes the outline.[1]

[1] A review of the whole subject of *Handedness, Right and Left*, with a full bibliography, is to be found in a volume with that title by Ira S. Wile, which has appeared since the foregoing chapter was written (Boston: 1934). Wile revives, and defends in great detail, the various theories attributing right-handedness to the rotation of the earth. 'Man,' he insists, 'has been influenced continually by forces deflecting him towards the sun,' *i.e.* towards the right : the forces that he specifies are partly physical (gravity, momentum, heliotropism), and partly psychical (enjoyment of light, veneration of the sun, and magical and religious superstitions based on sun-worship). By combining all these different theories into one ruling hypothesis, which he terms 'heliocentrism,' Wile seems open to a mild charge of sun-worship himself. The combination involves lines of argument not altogether compatible. If the mere rotation of the earth, or the mere direction of sunlight, acting afresh on each growing organism, were of itself sufficient to explain the asymmetry of the nervous system and 'man's persistent leaning movement towards the sun,' there would seem to be no need to invoke the psychic influences. Only in the northern hemisphere, however, are 'currents deflected towards the east, that is, towards the right' ; from the equator southwards they are deflected more and more towards the west. How, then, are we to explain the existence of right-handed individuals in the southern hemisphere, or, for that matter, of left-handed individuals in the northern ? The reply suggested is that 'many of the southern tribes may have migrated from the north,' presumably after the 'traits produced by the earth's movement . . . had been built into the history of the species.' Dr. Wile is evidently prepared to assume the inheritance of acquired habits on a scale which no contemporary psychologist would accept.

As regards the psychic influences, no doubt the veneration for the sun may largely be responsible for the good and evil qualities attributed by superstition to the east and to the west and perhaps to the right and to the left ; but I should be more inclined to attribute the respect for right-handedness to the prior right-handedness of the majority (which seems traceable even in the old stone age) and the later superstitions to the need for imposing consistent methods of behaviour upon all by means of rationalized sanctions where inheritance had hitherto failed. If 'social pressure' has led ultimately to 'anatomical compulsion,' this again must have been, not because of 'habit fixed by inheritance,' but rather because, during the neolithic and bronze ages, the left-handed man and woman were subject to varying forms of ostracism and so failed to marry and propagate their kind. (Cf. Sarasin, *loc. cit. sup.*, p. 295.)

CHAPTER XI

DEFECTS OF SPEECH

Significance.—Just as sight and hearing are the two main human senses, so hand-movement and speech—hand-movement guided by the eye and speech appealing to the ear—are the two typical motor activities of mankind. By their means civilized knowledge has been gradually built up, and by their aid it is re-expressed and re-acquired in each succeeding generation.

Of the two, the tongue is more important than the hand; and if, as we have just seen, an awkwardness in hand-movement forms a definite impediment to intellectual progress, we shall naturally expect a defect of speech to form an obstacle still more serious. Among the feeble-minded, defective speech is exceedingly prevalent; it is almost as common among those who cannot read; and among those who are backward generally, as our statistics will presently show, flagrant speech-defects are nearly four times as frequent as among the normal. Often the defects are so slight as to escape notice in the classroom, and are only detected by systematic testing and inquiry. And again, even when they have been observed, they may have received no special attention or adequate treatment. Nevertheless, through their indirect and cumulative influence, they impose a constant handicap upon the child in his regular school work; and, what is still more important, they frequently prove to be the superficial symptoms of some deep underlying disturbance that may menace his whole mental health.

Definitions.—The defects of speech that are at once the commonest and the most conspicuous are of two main kinds: first, lisping or lalling, and secondly, stammering or stuttering.

In the narrower meaning of the terms, to lisp is to pro-

nounce the sibilant *s* imperfectly, as, for example, 'thickth' for 'six'; and to lall is to substitute *l* for some more difficult consonant such as *r*, for example, 'plitty lobbin led blest' for 'pretty robin red breast.' By medical writers, however, the word 'lisping' has been widely adopted to cover all single or limited substitutions (usually the mispronunciation[1] of a single sibilant or fricative—*s*, *z*, *f*, *th*, etc.), and the word 'lalling' to denote any multiple or widespread set of substitutions (including mispronunciations of most other consonants besides the sibilants and fricatives)—in short, defects of articulation generally; and this usage I shall follow here.[2]

[1] It should be observed that the term 'mispronunciation' includes the complete omission of a sound. Thus, as we have indeed already discovered, an important form of lisping consists in the complete omission of sibilants: the high hiss of sounds like *s* and *sh*, not being heard by children suffering from high-note deafness, is not reproduced in their speech.

[2] The above classification of speech-defects was first explicitly suggested by Itard, a physician to the School for the Deaf in Paris, better known as a pioneer in the study of mental deficiency (*De l'éducation d'un homme sauvage*, 1798). In this country the classical work on speech defects has for long been J. Wyllie's *Disorders of Speech* (Edinburgh, 1894). It is only quite recently that the phoneticians, whose primary task is the study of normal speech, have turned their attention to a better description and classification of abnormal speech sounds (see, *e.g.*, Ida C. Ward's *Defects of Speech*, Dent, 1923—a most valuable little handbook, at once scientific and practical). The best foreign textbooks are those of Nadoleczny, *Lehrbuch der Sprach- und Stimmheilkunde*, Leipzig, 1926, and Gutzmann, *Physiologie der Stimme und Sprache*, Braunschweig, 1928. For a discussion of the more general problems of *Speech in Childhood*, see the useful volume with that title by G. Seth and D. Guthrie (Oxford University Press, 1935).

A more clearly defined terminology is still an urgent need. By its etymology, 'lalling' (Latin, *lallare*, to sing a lullaby, to lull a child to sleep with babyish talk) implies any form of infantile pronunciation. It is thus the appropriate word to designate the normal mispronunciations of the very young, and is still so used by many writers. But since the speech defects falling within the first of the two main groups distinguished above consist chiefly in the retention of babyish mispronunciations, no ambiguity is likely to arise if 'lalling' is also used to cover defects of articulation which, owing to the age of the child, can no longer be regarded as normal. To teachers the word 'lalling' seems rather strange; and many of them use the word 'lisping' to designate such defects. Personally, I should have preferred this extension of the word as more in line with its original meaning: (in Old English and in German, *wlispen* and *lispeln* seem first to have meant any faint or *whispered* speech, and so any indistinct or imperfect form of pronunciation). However, the

Strictly, too, stammering should be distinguished from stuttering. Stuttering is the spasmodic repetition of speech; stammering is the spasmodic arrest of speech. In stuttering the same sound, usually the first in an accented syllable or word, is repeated over and over again; in stammering there is a sudden halt, ending generally in an over-explosive utterance of the syllable that follows. The stutterer rhythmically re-commences; the stammerer silently sticks. The one says 'bub—bub—bub—bub—butter!'; the other says nothing, and then bursts out with a big 'BUTter!' Of these two forms of hesitating speech, a simple stammer is by far the commoner: stuttering is much less prevalent in actual life than in anecdote and on the comic stage.

A stammer is often merely incidental, an exceptional delay or interruption in the rhythm of speech owing to some passing emotion, not necessarily a thing to which the speaker is chronically subject; on the other hand, stuttering, as a rule, is an insistent habit of long standing, and, on the surface at any rate, strikes one as a mechanical rather than a mental action, a pathological symptom rather than the natural outcome of normal excitement. We shall, however, discover that a stutter commonly grows out of the same conditions that precipitate a stammer. Hence, stuttering may be considered a severe and reiterative form of stammering, and stammering as an abortive or incipient stutter. The two, therefore, may be conveniently classed together; and stammering, having the wider connotation, would seem the best generic term.[1]

more specific use of the word 'lisp' is to-day so widespread that an ambiguity might easily arise. The limitation of 'lalling' and 'lisping' to the pronunciation of *l* for *r* and of *th* for *s* respectively, appears to have been a later usage, due probably to the presence of *l* and *s* in the words themselves. When it is necessary to refer expressly to the single substitutions, I would suggest that *lambdacism* be used for the substitution of *l* for *r* and *sigmatism* for the substitution of *th* for *s*: these terms have a good authority (see *Oxford English Dictionary*, s.v.). In medical writings, 'dyslalia' (formed on the analogy of 'dyspepsia' and the like) supplies a convenient term for the more widespread trouble; but to lay readers words of Greek origin sound pedantic unless they are intended to describe a definite pathological symptom or disorder.

[1] An exact and satisfactory definition of stammering is not easy to formulate, and would scarcely be intelligible to the non-technical reader. I suggest

Incidence of Speech Defects among Normal and Backward School Children.—Figures for the frequency of speech defects have already been included in Tables XIII and XIV. In the London inquiry into backwardness, the percentages were as follows. Severe defects of speech[1] were noted in just over 1 per cent. of the control group, in more than 5 per cent. of the backward, and in nearly 11 per cent. of the mentally defective. Among the normal the only severe defect observed was stuttering or stammering; among the backward and defective the severer defects

that it might be defined as a spastic neurosis of co-ordination, disturbing the rhythm of fluent speech by producing involuntary contractions of the articulatory, vocal, or respiratory muscles—most frequently contractions of the articulatory muscles at the stop positions during the attempt to enunciate initial sounds or syllables. See below for a fuller description.

The English word 'stammer' is apparently derived from the same root as the verb 'to stem'; some connect it, directly or indirectly, with the root of the German word *stumm* (dumb). It seems, therefore, to imply that particular form of speech in which the flow of the speaker's words is suddenly stemmed. In English the word 'stutter' is a far more recent acquisition: it does not seem to occur before 1570. Wyclif (1388) used the word 'stuttynge' (*Isaiah* xxxii, 4, where the Authorized Version has 'stammerers'). This later frequentative form describes the *reiterated* stoppage; and appears to have come into use as a more technical term to distinguish the more definite defect.

In German the corresponding words *stammeln* and *stottern* seem to imply much the same difference. Most dictionaries, in German as in English, treat the two words as synonyms. Sanders' *Handwörterbuch*, however, defines *stammeln* as 'redegehemmt in abgebrochenen Silben sprechen' and *stottern* (connected with *stossen*, 'to beat') as 'stockend und wiederholt anstossend reden': the former describing the broken speech of the apprehensive or hesitant, the latter the repetitions 'infolge eines Sprachfehlers.'

Medical writers in Germany often use *stammeln* to mean what I am here calling 'lalling,' thus distinguishing it from *stottern*, which is used to cover both stammering and stuttering, as above defined. (English writers incorrectly refer to this as if it were a regular distinction observed in non-medical German parlance.) Scripture, working largely in Vienna, and one or two authorities in this country who have followed him, have sought to bring the use of the English word 'stammering' into conformity with the medical usage of *stammeln*. This, however, seems such a violent distortion of the regular English meaning that it is, I imagine, never likely to become general and may easily lead to misunderstanding.

[1] Under 'severe defects' I count only those cases which could hardly be missed even by an unobservant layman.

were of various kinds, 4 out of the 5 per cent. being stutterers or stammerers. Mild defects, mostly lalling and lisping, were found in 4 per cent. of the normal (6 per cent. of the boys and 2 per cent. of the girls), in 9 per cent. of the backward (11 per cent. of the boys and 7 per cent. of the girls), and in as many as 13 per cent. of the mentally defective. Thus, of mentally defective school children, nearly one quarter suffer from some form of defective speech.

In the briefer investigation at Birmingham, only the severer defects were noted; but the general distribution appeared to be much the same.

During the course of the other psychological surveys that I have made from time to time in London schools, I have endeavoured to procure data somewhat more detailed and exact. Table XX gives the results arranged according to sex and age. Judging by the final averages, it will be seen that about 5 per cent. of the total school population suffer from speech-defects generally, and about 1 per cent. from stammering, but that there are marked differences between boys and girls and at various periods of school life.[1]

[1] Both as a whole and as regards sex and age differences, my own figures tally fairly well with those obtained in London nearly thirty years ago by Dr. Kerr (*L.C.C. Report*, 1909, p. 50). My percentages seem somewhat lower; but evidently there has been but little change throughout this period.

The small group of normal children used as a control in the present investigation included comparatively few children under the age of 8; on the other hand, they were drawn, it will be remembered, from poorer and less cultured classes. Consequently they exhibit a slightly larger proportion of speech-defects, particularly of lalling and lisping, than would be found among London children generally of the same age.

The percentages most commonly cited for comparison are those of Conradi, who in a census of 87,000 American children found 2·5 per cent. to be suffering from speech-defects and 0·9 per cent. to be stutterers; these proportions are slightly smaller than those observed in London ('Psychology and Pathology of Speech Development,' *Ped. Sem.*, XI, 1904). In other countries the figures reported for stammering are somewhat higher; nearly always, however, they are in the neighbourhood of 1 per cent.: *e.g.* Belgium, 1·4 per cent.; Germany, 1·6 per cent.; Russia, 1·7 per cent.; Italy, 1·0 per cent.; Spain, 1·2 per cent. It is noteworthy that the frequency is smaller in south European nations than in northern. It would be interesting to consider whether this is related to the slighter tendency to repression that is supposed to characterize the Southern temperament and tradition, or to the more fluid quality of south European languages. But, of course, the

TABLE XX. FREQUENCY OF SPEECH DEFECTS AT DIFFERENT AGES

Age.	Lalling or Lisping.			Stammering.			Total.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	Boys.	Girls.	Average
4–	[39·25]	[46·17]	[42·71]	[0·39]	[0·51]	[0·45]	[39·25]	[46·71]	[42·98]
5–	19·89	9·77	14·83	0·63	0·60	0·62	20·01	10·46	15·23
6–	6·63	2·19	4·41	0·80	0·52	0·66	6·84	2·52	4·68
7–	9·08	3·78	6·43	0·97	0·61	0·79	9·76	4·13	6·94
8–	6·71	2·54	4·62	1·82	0·54	1·18	7·44	2·65	5·04
9–	4·59	1·22	2·90	1·76	0·51	1·13	5·69	1·64	3·66
10–	2·41	0·76	1·58	1·71	0·37	1·04	3·61	0·98	2·29
11–	3·36	0·81	2·08	1·64	0·42	1·03	4·35	1·13	2·74
12–	1·57	0·92	1·24	2·14	0·23	1·18	3·21	1·01	2·11
13–	1·65	0·73	1·19	2·32	0·64	1·48	3·08	1·27	2·17
14–	[1·63]	[1·02]	[1·32]	[2·53]	[0·36]	[1·44]	[4·05]	[1·26]	[2·65]
Average [1]	6·21	2·52	4·36	1·53	0·49	1·01	7·11	2·87	4·99

differences shown by the actual statistics may largely depend on the extent to which milder cases have been included, and on the thoroughness with which each individual child has been examined. From my own inquiries it would appear that the amount of stammering is nearly twice as great in Jewish schools as elsewhere, and I have also noted a rather high percentage among children coming from certain parts of Scotland—a point which seems confirmed by recent surveys north of the Tweed.

Most observers note that stuttering is about three times as common in boys as in girls (cf. Nadoleczny, *loc. cit. sup.*). And the fact that the males (whose heads are larger than the females') and Jewish, Prussian, and Slavonic races (whose heads are brachycephalic) appear to suffer most may suggest to the speculative that the greater frequency of speech-defects might perhaps be related to the greater liability to pressure and head injury at birth which is supposed to be the fate of those whose heads are large or broad. But with the doubtful exception of one or two low-grade defectives, I find nothing in my case-histories to connect stammering with this cause.

Variations with age are clearly brought out in a table given by Hartwell, who has averaged the six best continental studies (*Report of Director of Physical Training*, Boston, 1894, pp. 69 *et seq.*): these seem in the main to tally with the observations noted in the text.

[1] The figures in the last three columns give the total number of children exhibiting one or both forms of speech-defect; as lalling not infrequently occurs in a child who also stutters, these totals are smaller than would be obtained by simply adding the figures from the corresponding columns to the left. In calculating the grand averages at the foot of the table, the bracketed figures for ages 4 and 14 have been omitted, since the children in these two groups were not all in attendance at elementary schools, and the samples were small and possibly selected.

Incidence of Speech Defects according to Sex and Age.—Among boys, it appears, stammering is more than three times as common as among girls, and lisping and lalling more than twice as common. The sex-difference is no doubt in part connected with the inherent verbal fluency of the female, and with the natural superiority that she seems to display in accuracy and grace of all finer movements. But there is perhaps a second factor. Speech is a mode of social intercourse, and is therefore most likely to suffer in those who are susceptible to emotional strain of a personal or social character. Girls adapt themselves more readily to social situations, and are treated more indulgently by the older persons with whom they are thrown into contact; boys, on the other hand, are supposed to need a sterner treatment, and at the same time react more unfavourably to personal authority.

Of the two chief forms of defect, lisping and lalling are characteristic of the very young; they tend to diminish rapidly so soon as the school period commences, and the diminution continues pretty steadily up to puberty. If the figures for ages 4 and 5 can be trusted, at least one-third of the children in the social classes from which the elementary population is drawn lisp and lall on first entering school. Among boys, the number showing such defects at the end of the infant school period is still nearly 9 per cent., but by the age of leaving school it has sunk to barely 1½ per cent. Among girls, the proportion is only about half as great during the infant school period, and declines yet more swiftly.[1] The temporary increase in lisping and lalling, discernible in both sexes about the ages of 7 and 8, appears to be connected with four different factors: (i) the after-effects of infectious infantile diseases (whooping-cough, measles, and the like) which not only weaken the child's general physical and nervous health, but sometimes disturb his

[1] Even before the infant school period, girls develop more rapidly in regard to speech than boys; but they seem to preserve their babyish pronunciation a little longer. There are, however, wide differences dependent upon social class, nervous temperament, the number of children in the family, and the like. The worst cases of speech-defect, and the severest cases of resulting backwardness, were found among girls from good families.

respiratory mechanisms, and not infrequently leave his hearing impaired; (ii) the onset or increase of local troubles affecting the nose and throat (adenoids, chronic catarrh, etc.); (iii) local and general disturbances arising from the second dentition; and (iv) the change to the more rigid methods of the junior school. In both sexes there seems to be another slight increase towards the age of 11 or 12, connected either with the transference to the senior school, or with the approach of puberty and the derangement of the vocal organs and of general nervous stability which puberty so often entails.

While lalling diminishes during the school period, stammering, at any rate among boys, tends decidedly to increase, and appears to reach its highest at or soon after the onset of puberty. During the first year or two in the junior department the number of lallers is more than halved; but the number of stutterers is almost doubled. On the whole, however, the influence of age is not so marked with stuttering as with lalling. For boys my figures rise from about 0·6 per cent. at the age of 5 to nearly 2 per cent. at the age of 8, and again, after a temporary decline, to 2½ per cent. at the age of 14. For girls the figures vary far less; and, owing to the fewness of the cases, the effects of age are difficult to trace with certainty. The maxima, however, seem to occur about a year earlier with the girls.

Where detailed records are obtainable it would appear that most of the older stutterers have shown some slight tendencies in that direction even before the age of 7, and nearly all form their habit before the age of 16. In its onset, therefore, stuttering is pre-eminently a disorder of the school period, just as lalling is primarily a disorder of the pre-school period.[1] Among the very youngest, stutter-

[1] If the individual case-histories were our only source of evidence and were taken at their face value, they would suggest that most cases of stuttering commenced at puberty. This inference has constantly been drawn by writers whose experience has lain mainly among adults and who have made no survey of the incidence of such defects among younger children. In my experience the effect of puberty is more often to aggravate a pre-existing disorder, which, during its earlier stages, may perhaps have been so slight that the parents failed to notice or remember it. At puberty, too, the stutterer becomes

ing seems first to occur as a mere persistence of the rhythmic repetitions that nearly always mark the infant's early efforts to babble and speak: most tiny children hesitate breathlessly when excited, because they are not yet expert speakers and can neither find nor formulate words quickly enough to keep pace with their feelings. But there is an unquestionable increase during the first two or three years at school—due partly, perhaps, to the slow learning of a new use of speech, namely, reading, and partly, no doubt, to the strain imposed upon them by the new social environment. Another increase, still larger, may be observed just before or just after the age of promotion to the junior department. This may at times be connected with the child's first introduction to yet another method of verbal expression, namely, writing; but is more often attributable to one or more of the four groups of conditions enumerated above.[1] A third increase occurs towards adolescence, and rises to a maximum at about 16. The earlier cases in this adolescent group—pre-pubertal rather than pubertal—are often choreic in character and show other choreic manifestations, the whole trouble tending to disappear spontaneously with the close of puberty; in the later cases the trouble may be associated with the emotional changes of puberty itself, and in boys often synchronizes with the breaking of the voice: but again much is probably due, not directly to spontaneous physiological disturbances, but rather to the change to a new and more exacting life, as the child leaves school for business.

It may be noted that defects of either kind are frequently preceded by a marked delay in learning to talk. According to the data gathered during my previous surveys,[2] the

more sensitive regarding his disability; and, particularly if, at the same time, he leaves his old school for another or for work, he grows more acutely aware of it as a social handicap. His tendency is thus to post-date its onset.

[1] See pp. 366–7.

[2] *Report on the Distribution of Educational Abilities*, p. 17. The ordinary definition of 'beginning to talk' is 'to use for the first time a word intelligently, associating the idea with the object.' But the power to use a *single* word is shown at widely varying ages by different children, and may appear long before any continuous progress in speech commences: a large number can use just one word ('dadda,' 'mummum,' 'tata,' 'baba,' or the like) as early as the age of nine months. No mother ever asks the investigating

normal Londoner begins to talk at an average age of 1·1 years; the defective not until an average age of 2·3 years. The dull fall roughly midway between the two, beginning, on an average, at 1·5 years: in the retarded group at least 12 per cent. did not start to talk until after 2 years of age, and as many as seven cases were noted in which the child had reached the age of 4 before he could frame a complete sentence or use more than half a dozen words spontaneously. On the other hand, the merely backward, those who are neither dull nor yet afflicted with any impediment of speech, apparently start talking almost as early as the normal child, namely, soon after the age of twelve months. Children of normal intelligence and attainments who suffer from speech-defects appear, on an average, to have been almost as late in learning to talk as the definitely dull; the median age at which they begin to talk is approximately 1·4 years. Children who suffer from speech-defects and are dull and backward in addition, prove to have been almost as late as the high-grade feeble-minded; the median age at which they began to talk is apparently about 1·7 years. In these cases, where there is a history of a backwardness in talking, unexplained by backwardness in general intelligence, inquiry often reveals that one or more of the relatives were also backward in talking or had suffered from some form of speech-defect.

This suggests a partial solution to a question which will confront us later on and which we shall find has been largely overlooked: granted that speech-defects often arise, now as an incidental feature in the irregular development of many dull children, and now as an incidental reaction to emotional or nervous stress, why, we may ask, in these particular individuals, does the reaction or the irregularity take the specific form of speech disturbance, and not of some other aberration? The answer would seem to be that, in addi-

psychologist for a definition of his phrase; as a rule, she seems implicitly to take it to mean the beginning of a special phase of growth marked most conspicuously by the rapid acquisition of a vocabulary. My own criterion, therefore, has been the first emergence of the power to use four or five childish words appropriately, followed by a steady increase in vocabulary during the subsequent months.

tion to the general dullness or the general emotional strain, there must, as a rule, be some predisposing weakness in the speech mechanisms themselves, inherited, innate, or left by local ailments.

Influence of Delayed or Defective Speech on School Progress. —Retarded speech and retarded school progress interact in various ways. Children who are late in talking are not likely to be sent to school until an older age than the rest, and this in turn prolongs the babyish stage of their talk. Then, when they arrive, the tardy development of their speech still further hinders them from taking a normal part in the work of the infants' school; and even at this early stage they may hit upon the device of keeping up a babyish attitude to cover or excuse their childish incompetence. Thus from the very beginning their education is held back.

But this is not the only manner in which the two features are connected. More often than not, the delay in speech is itself only a special symptom of a slowness in mental development all round; and this general slowness will be the main factor impeding their further progress: it will prevent them from making up for their bad start, and will continue to hamper them all through their school career.

In favourable circumstances, the slighter defects of speech are by no means incompatible with exceptionally high attainments. In such cases, they are perhaps rather to be regarded as stigmata of an imperfect neuro-psychical organization than as grave retarding factors in themselves. Among scholarship children I find over 2 per cent. suffering from mild disturbances of speech; and of the supernormal boys studied by Terman, as many as 4 per cent. were afflicted with a slight stammer.[1] Speech-defects, occasionally painful and persistent, have been reported of some of the most illustrious personages of the past. Demosthenes, Aristotle, Alcibiades, Æsop, and Virgil, all had impediments in their speech. Charles Lamb, Charles Kingsley, Charles Dodgson (better known as Lewis Carroll), Boyle the physicist, Priestley the chemist, Erasmus Darwin the biologist and poet, Walter Bagehot the banker and

[1] *Genetic Studies of Genius*, I, p. 199.

essayist, are described as having stammered badly.[1] Indeed, more than one neurologist [2] has declared that stammering is especially associated with periods of accelerated brain-growth, and is therefore a natural characteristic of bright individuals. In such cases, however, the true explanation is perhaps rather to be sought in the uneven or irregular development which speeds up certain functions of the child's psychophysical organism more suddenly than others. If his ideas are expanding more rapidly than his machinery for uttering them, or if one part of his speech-mechanism is ripening more swiftly than another, then slurring, spluttering, or stammering may arise as a natural consequence.

Of the two main types of defective speech—so far as my own case-histories can be trusted—stammering seems more likely to form a serious cause of backwardness, while lisping, lalling, and indistinct speech are apt to be characteristic of the congenitally dull. The closeness of the correlation, however, depends largely on the age of the particular group studied: during early years, as we have seen, defects of articulation are quite common among the normal; during adolescence stuttering is by no means infrequent among the exceptionally bright.

The handicaps imposed by defective articulation are most easily seen in oral and linguistic subjects. More particularly it is liable to hinder the child's early efforts at phonic analysis, and so prevent him from learning to read as quickly as the rest. We shall find later on, however, that a weak power of auditory discrimination often lies at the root of both disabilities—of backwardness in reading as well as of indistinct speech. Hence it is not always possible to decide what is cause and what is effect.

Stammering, on the other hand, is one of the most tragic of all the minor disorders of school life. It holds back the child's development in many obvious ways. The stammerer can never enter freely into any interchange of conversation,

[1] In his *Study of British Genius* (1904) Havelock Ellis states that at least thirteen eminent persons on his list were victims of a stammer. Minor defects, particularly lisping and a shrill, high-pitched, feminine or childish voice, seem to have been commoner still (*loc. cit.*, p. 197).

[2] *E.g.* Clouston, *Neuroses of Development*, p. 286.

whether with teachers, school-fellows, or strangers. He is shy of answering in class. He dreads asking questions for himself in front of other pupils. Hence, nearly always the uncured stammerer becomes backward at his lessons. At home his relatives lose patience with his slow and irritating utterance, and seldom hesitate to criticize his failing on all public occasions. Everywhere he is likely to be looked upon as foolish or queer ; and few of his comrades can resist the temptation to mimic or mock him. As a result, he soon prefers silence to ridicule, and grows up with a character permanently warped. From most of the higher vocations, and from any career that brings him into close contact with his fellow men, he feels of necessity excluded. He renounces all ambition ; becomes diffident, embittered, or morbidly eccentric ; and looks forward to nothing but a life of moral suffering. Yet, in spite of the singular persistence of the trouble, there are few disabilities which, taken in hand during early childhood, can be more readily, more surely, or more cheaply cured.

The Examination of the Speech Defective.—Since defects of speech are so prevalent among school children, particularly among the dull and retarded, and since few other defects show so high a correlation with backwardness in school work, I have made a special investigation into their causes and treatment, and shall venture to discuss the results in detail here.

Whether the trouble is manifestly hindering the child's school work or not, all serious cases should be reported by the teacher to the school medical officer, so that a proper physical and neurological examination may be carried out. Where necessary, surgical, medical, or hygienic measures will then be advised ; and, in large educational areas, the severest cases will probably be handed over to a specialist at a clinic or speech-centre for appropriate training and instruction. Owing to difficulties of travelling, however, if for no other reason, the slighter forms will generally be left for the teacher to cope with in the ordinary school. And in every instance it will be extremely helpful if the child's own teacher can make first a competent study of the precise character of the impediment. This preliminary work can

be performed more thoroughly by the teacher than by the medical inspector, since the teacher has at his disposal fuller opportunities and far more time.

Accordingly, I may begin by reviewing the chief points to be observed, and at the same time indicate the procedure that I have found most fruitful in my own investigations. Generally, the examiner will discover that the defect, whether stammer or lisp, is confined to particular sounds, and that these sounds are usually one or more of the harder consonants. With each individual child the nature of both the troublesome sounds and of the consequent distortions should first be noted, and an endeavour should subsequently be made to ascertain the immediate and remoter causes of the disturbance.

I. *Lisping and Lalling*

Methods of Investigation.—While the stammerer meets his difficulties by an additional violence of effort, the laller commonly evades them by substituting an easier sound. For example, to produce a Southern English *r*, as in the word 'robin,' the tip of the tongue has to be curled up towards the palatal ridge just above the teeth.[1] For the tiny child this is almost as hard as trilling the uvula is for the Englishman who is trying to produce a Parisian *r*. The laller, like the Englishman trying to speak French, substitutes a simplified or a more familiar movement: he says 'lobbin' or 'wobbin' instead.

With the child who lisps or lalls, therefore, the first step is to determine what are the movements of the lips, or tongue, or palate, that he seems unable to achieve. This means undertaking a systematic analysis of the nature of his mistakes. To find out what particular substitutions the child is habitually making, the quickest method will be to apply some comprehensive test. Merely to ask the

[1] I have known many teachers instructing lallers to 'set the tongue-tip in rapid vibration,' under the impression that an English *r* is always rolled. This enormously increases the child's difficulty; and, if successful, would lead to a pronunciation quite unnatural for most of us. Except in the North, the initial *r* is always a fricative, and even between two vowels only one tap of the tongue is made.

child to repeat a few hard words is not enough: many will echo a sound correctly, when they would slur it in their spontaneous speech. For a scientific record it is essential to work through the whole phonetic series, and methodically examine every consonant and vowel. In an appendix I have given a list of the sounds which in practice need more especially to be watched, together with the mispronunciations most commonly heard.[1]

As a preliminary, the child may be asked to recite the alphabet in the ordinary way. He may then be tried with a specially selected set of words, compiled so as to exemplify all the harder sounds in all the possible positions—initial, final, medial (between two vowels), and combined with other consonants immediately preceding or succeeding it. Nor is one example for each sound sufficient. Many older children, for instance, preserve their childish lisp only with familiar or unaccented words, and pronounce new, learned, or emphatic words correctly. I have known two or three students with a pronunciation as mixed as the following: 'Vis fret of authority on ve part of his foughtless faver called out all ve sympathy of Theophilus': here words of three or more syllables are correctly pronounced; the lisp affects only the simplest. The surest and most thorough plan is to collect a set of pictures and common objects, chosen because their names involve all the consonantal sounds in order. The child is then asked what each is called. The teacher does not say the names himself.

A set of alliterative sentences is useful to bring out special difficulties, as well as to afford concentrated practice: 'Round the rugged rocks the ragged rascals ran their rural races'; 'She sells sea-shells by the sea-shore'; 'Peter Piper picked a peck of pickled pepper'; 'Gregory goes gaily galloping gallantly towards the gate';

> 'I slip, I slide, I gloom, I glance,
> Among the shimmering swallows;
> I make the mottled sunbeam dance,
> Against my sandy shallows.'

[1] See below, Appendix IV.

Most of the books on speech-training provide material which can be used for this purpose.[1]

Idioglossia.—In extreme cases there is so much lisping and lalling, and articulation is so slurred and scamped, that the child seems to be speaking a language of his own. The condition is accordingly described by medical writers as *idioglossia.*[2] The child's meaning can nearly always be interpreted by his parents and by specialists familiar with such distortions: but to the inexperienced stranger everything he utters sounds as incomprehensible as Arabic to the untravelled Englishman.

Among pupils in upper departments of the ordinary elementary school an out-and-out case of idioglossia is, I fancy, hardly ever to be found; but it is by no means rare among backward children in the infants' department or among defectives in the special school. Among older boys and girls, whose intelligence, though dull, is perhaps not actually deficient, the peculiarity is occasionally encountered; but it is then for the most part confined to better-class families, and hence seldom met with outside private practice.

When he first hears it, the teacher or doctor is apt to confuse it with mere baby-talk or with the senseless jabbering of the aphasic imbecile. A closer study will show that this impression is not altogether justified. As a rule, the idioglossic speech will be found quite easy to translate once the underlying principles are grasped. It consists merely in the combination, in exaggerated form, of minor defects of speech, each of which by itself is quite common and familiar. At times the consonantal changes are highly complex; but, in any given case, some intelligible system may nearly always be traced. Elsewhere I have pointed out how substitutions made by young or subnormal children often seem to follow much the same phonetic laws as have been found in part to regulate the evolution of modern languages from their more primitive

[1] See references at the end of this chapter, p. 440.

[2] The word seems to have been first coined by Dr. Hall White (*Medico-Chirurgical Trans.*, 1891, March 10th). He apparently derived it from Strabo's Greek expression—ἰδιόγλωσσος ('having a tongue of one's own').

forms; and idioglossic speech perhaps affords the most striking illustrations of the parallel.

Recently a clergyman brought his only son to see me: the boy was a well-grown lad of 10 who proved to have a mental age just over 8. In the course of my examination I asked him to recite any little poem he knew. Thereupon he plunged into a rapid rigmarole which (after one or two repetitions) I managed to get down in phonetic script. For simplicity the first sentences may be transcribed in dictionary spelling as follows: 'Ah bardy tzardy debbut; arrow piddi tabe; die chitta chub; die wippy tut . . .'

Now if we take what philologists term 'Grimm's law' and the 'law of denasalization,'[1] reverse them, and apply the principles so deduced to the consonants contained in this brief specimen, we get one step back towards the original: namely, 'Ah Farthi 'ch art in evvun; arrow be Thy name; Thy kingda kum; Thy wi' be dun . . .' Except for the alteration or elision of the *l* sounds, this is practically identical with the Londoner's ordinary pronunciation of the opening clauses of the Lord's Prayer.

The teacher, and even the phonetician, talk of a child as changing the 'sounds.' From the child's own standpoint, however, what is simplified is not so much the audible sounds as the movements of articulation. Hence we must not expect the new sounds literally to resemble the old in their acoustic characteristics: what we must look for is a similarity of movement. Except in vowels and in rhythm, 'tzardy debbut' does not sound like 'which art in Heaven'; but the positions taken up by the tongue and lips are very much the same for both phrases.[2]

[1] Roughly speaking, Grimm's law states that fricatives (like *f*, *v*, and *th*) tend to become converted into the corresponding voiced plosives (*b* and *d*), voiced sounds (like *b* and *d*) into the corresponding unvoiced sounds (*p* and *t*), and unvoiced plosives (like *t* and *k*) into the corresponding affricates or fricatives (*e.g.* *ts* or the German *ch*). These tendencies are characteristic of the Teutonic group of languages (English and German, for example) as compared with the older Indo-European forms; and the sub-group to which English more particularly belongs is further characterized by a tendency to denasalization, especially before consonants.

[2] As we shall see in a moment, speech in young children is controlled not so much by the ear as by feelings of the movements and postures—by the

This explains why such utterances strike the ear as so remote from everyday speech. We recognize our words more by their consonants than by their vowels. In shorthand as in Hebrew, the signs for most of the vowels may be dropped, and the manuscript still remains legible. Let the reader try to make out the following sentences :

(i) .i...e .a.. .o..e. .a. i. ..e .o..e. (a phonetic transcript will be fairer for those who know the symbols: .ɪ.l .æ. .ɔ.ə .a. ɪ. .ə .ɔ.ə).

(ii) L.ttl. J.ck H.rn.r s.t .n th. c.rn.r

The second can be guessed at once: the former—which is the same couplet with the consonants omitted instead of the vowels—is almost unreadable.

The reason why the idioglossic puts us on an entirely wrong track is that he distorts nearly all his consonants in a manner which the ear alone cannot follow. The quickest way to understand him, therefore, is to ignore the consonants and to note only the vowels.

Here is a still more degenerate specimen of idioglossic speech. The speaker was a borderline defective of 8½. 'Ow Dah-er ittarty. Nedden. Ah-wo de Di day. Tie tiddy tub. Tie iddy dud ot er addy tiddy Nedden. Dib ut tis day ow day-wy bed . . .' Once again, what I have set down looks at first sight sheer gibberish, a haphazard medley of meaningless noises. If, however, the reader will recite it to himself, omitting every consonantal sound, he will divine at once what the child was trying to say. I had, in fact, asked him to recite the Lord's Prayer, in order to obtain a record comparable with that of the foregoing case.

In this example it will be seen that one labial, three dentals,[1] and a single semi-vowel, do duty for all the con-

kinæsthetic sense rather than by the sense of hearing. The existence and importance of this muscle-sense is continually overlooked even by phoneticians. Thus, to take a well-known philological example of *Lautverschiebung*, illustrating the two laws just mentioned, 'Dentes,' 'Zähne,' and 'teeth' all sound so different that the layman finds it difficult to conceive that they are all three derived from one and the same root ; yet the movements made to pronounce them are very similar—the last two being in effect little more than simplified efforts at pronouncing the first.

[1] The dentals, it may be added, were articulated in the French fashion

sonants in the English tongue. The gutturals, the posterior linguo-palatals, and the fricatives, are invariably elided or changed. It was the same in the child's ordinary chatter. Asked about his pets, he readily replied : 'Ah dot butti-yat 'tome. 'E'd dot e'er tut dyay-did eard.' ('I've got a bunny-rabbit at home. He's got ever such great big ears.') Here, it will be noticed, not only an infantile pronunciation, but also infantile phraseology and words are still largely preserved.[1]

Lisping, lalling, and idioglossia might be regarded as increasing degrees of the same form of specific backwardness, namely, a retarded development in vocal articulation. In its general nature, speech manifesting defects of this type tends to retain the special characteristics of baby language, though that is by no means its only feature. All infants lall and lisp at first : nearly all of them learn to pronounce their *d*'s and *m*'s before they can say their *r*'s and *s*'s, and with most of them a *th* is the last sound to be learnt. Labials and linguo-dentals—the easiest of the consonants, and hence, as a rule, the first to be acquired—are consequently substituted for the harder. These substitutions persist as habits; and, like other infantile characteristics, are dropped by some children very much later than by others. Simple lalling, therefore, can only be regarded as abnormal if it continues after the age of about 5, that is, after the child has been in the infants' school for about a year ; and lisping, only if it persists after the age of about 7, that is, when the time has come for the child to be transferred to the senior department. Naturally, in the backward such infantilities last longer, since the backward reach these mental stages at a later date.

with the tongue protruding and placed against the edge of the upper teeth, instead of against the gum ridge. This is often the case with idioglossic children, and renders their speech still more unlike intelligible English.

[1] Miss Ward gives a highly interesting example of what was apparently idioglossia in a girl of twelve, formerly tongue-tied in the literal sense. The training was successful in a very short period. (*Defects of Speech*, 1923, pp. 41 *et seq.*). Another detailed study of a case of idioglossia, with references to earlier instances, will be found in the last chapter of Leonard Guthrie's book on *Functional Nervous Disorders in Childhood*, 1909, pp. 270–93

In certain respects, however, the speech of the lalling school child, who is otherwise all but normal, differs significantly from the baby talk of the prattling infant and the young defective. Lalling shows lack of ear-guidance or of mouth-control; baby talk implies lack of developed intellect. The contrast is most striking when the laller's intelligence is up to the average, and his character fully mature for his age. The syntax, the idiomatic turn, the grammatical structure of his sentences, are then far more correct and intricate than those of a baby or defective. His pronouns and his verbal inflections are all accurately used; his announcements are longer and more involved; his vocabulary is far more apt and extensive; he no longer takes refuge in gesture, pantomime, or pointing. Thus, unconsciously complying with the maxim of the Duchess at the croquet party, he is quite able to take care of the sense, but leaves the sounds to take care of themselves—which they do very badly. In the extreme case of the idioglossic child it is these subtler features of his speech, much more than the ease with which his jumbled speech can be followed, that provide the best key to his true mental level.

Causes.—The contributory factors leading to lalling and kindred defects are very diverse. It is essential, therefore, that the intelligent teacher should possess a detailed notion of the different influences that may be operative. Medical writers commonly distinguish two main causal types—'organic (or mechanical) dyslalia' and 'functional dyslalia' respectively. In the former the defect is attributed to some physical deformity—such as irregular teeth or a shortened soft palate; in the latter no such physical cause can be discovered, and we are left to infer some psychic basis—a 'bad habit,' a 'nervous shock,' or perhaps an 'inferiority complex.' The distinction between the two types is useful as indicating the first problem in making a diagnosis; but in most cases the causation proves to be far more complex than this simple classification would suggest. Most of the so-called organic cases are really mixed; and almost all the peculiarities that are commonly attributed to a mechanical defect may also arise from purely functional causes. Nearly

always a more thorough investigation will reveal that several factors are co-operating. In the most typical instances, there seems to be first of all a more general retardation of development, sometimes intellectual, sometimes emotional, and then, in addition, some anatomical, physiological, or hereditary defect affecting more specifically the mechanisms of speech themselves.

Some notion of the different factors that may be at work can be obtained from a brief statistical analysis of a small group of cases that I have studied more intensively. The children were mainly between the ages of 6 and 12—72 boys and 45 girls, referred to me for various reasons, but all marked by a definite tendency to lisp and lall.

(1) In 36 per cent. of the cases the child's intelligence was itself so retarded that he fell definitely into the category of the *congenitally dull*. Except in one or two boys bordering on mental deficiency, the impediment was of a relatively simple type ; and the backwardness in speech development appeared to be a special manifestation of the general retardation of all the higher intellectual processes. These cases, it may be noted, were chiefly found among children from the poorer homes.

(2) Not infrequently, however, the childishness was more superficial than real, and seemed attributable to a kind of *hysterical fixation* at a babyish stage. In 18 per cent. of the cases the child was an only child, seldom mixing with others of his own age ; in 24 per cent. he was the youngest of his family, and too often manifestly treated as such—a little Benjamin, screened, coddled, idolized, and even at the age of 10 or 11 still helplessly dependent on his mother.

All unintentionally, the mother herself frequently fosters her child's mispronunciation by constantly prattling to him in baby-language, by taking his own childish babble as quite natural, and even referring to it as a 'pretty little lisp.' Then, later on, his laziness or carelessness, or an inertia in shaking off such infantile habits, or perhaps even a covert desire still to be treated as a baby, helps to maintain a mannerism that the parent has unwittingly instilled. In most of the cases of this type other nervous symptoms were also observable, much as in cases of stuttering ; and, as with

stuttering, the defect was apt to vary with the child's emotional condition, being, for example, distinctly aggravated by anything that would heighten feelings of inferiority or self-consciousness, and temporarily dropped during spells of self-assertion. Often it could be noted that, after the child had discarded his babyish ways in ordinary conversation, he would nevertheless revert to them on special occasions—when he wanted to coax and cajole, or when he was suffering or recovering from some intercurrent illness. Frequently the relatives themselves were emotional or highly strung. In 4 per cent. of the total group there was a history of insanity, and in as many as 13 per cent. what may be loosely described as a neuropathic taint.

Conditions of this kind were most commonly observed among children from the better classes. Thus, generally speaking, the lalling of the bright child from the good home is neurotic lalling, and often resembles an affectation; while the lalling of the dullard from the poor home is negligent lalling, and sounds rather like an exaggeration of the slack or slovenly speech that he hears around him.

(3) In some *heredity* seems to play a more specific part. In as many as 28 per cent. other members of the child's family were reported as having suffered from delayed or defective speech. These other members were mostly parents or older brothers or sisters: this perhaps was because the younger members were frequently too young for a definite report to be expected, and about the remoter members information was often unavailable. Under such conditions, of course, it was almost as likely that the defect had been handed on by simple imitation as that it was due to some inherited predisposition; and in three of the children several of the mispronunciations could be readily traced to an earlier companion who was himself not a member of the family. After all, nothing is so quickly copied by the young as an oddity of speech. But in at least a dozen instances, where fuller inquiries could be made, I have found a history of speech-defects or of retarded talking in remoter members whom the child had never seen; and here, too, the child's own defect was generally more severe than usual.

(4) In many of the remaining cases, including more especially those whose heredity, intelligence, and nervous condition appeared comparatively sound, there was some incomplete development of the child's speech-organs, often amounting to a definite *anatomical deformity*, and likely to hinder the proper formation of consonantal sounds. This was noted in 31 per cent. of the cases; but in only 9 per cent. was the deformity of such a severity or nature as to be regarded as practically the sole cause of the speech-defect. Where such conditions alone are operative, the resulting mispronunciations may differ slightly from those that make up ordinary lalling or lisping. Lisping, in particular, seems very commonly traceable to present or past deformities of this kind—most frequently irregularities of the teeth. But even here the mental or neurotic element was often contributory, since it was easy to show that nearly all children could, with a little assistance, produce an *s* correctly.

The deformities themselves may be of various kinds. The most striking, both in its nature and in its consequences, is the cloven palate: this, however, is sufficiently distinctive to deserve separate discussion later on. A palate which is merely too short or too high, without being actually cleft, may interfere considerably with proper resonance; and a palate which is V-shaped instead of gently curved in the front may be out of easy reach of the tongue-tip and so render *t*'s, *d*'s, *s*'s, and *r*'s very difficult to produce. By far the commonest malformations are those caused by ill-placed or misshapen teeth. Late appearance of the incisors may prevent the proper production of sibilants and dentals; crowded, irregular, or over-prominent front teeth are apt to make all utterance obscure: such troubles are at the same time often associated with a distortion of the palate itself. Here the dentist can do a good deal. But even after he has done his best, the teacher, as a rule, has still to cope with the long-standing errors in the movements of the lips and tongue persisting by sheer force of habit.

Of minor physical factors one of the most frequent is local obstruction, with or without inflammation, in the passages of the nose or throat. Enlargement of the lym-

phoid tissue behind and above the soft palate—'adenoids' as it is commonly called—was noted in 24 per cent. of my cases. 'Adenoidal speech' is familiar enough to the teacher; but it is not generally recognized that adenoidal growths may affect a child's speech in two different ways, and so produce two somewhat different types of speech distortion. First, the heavy growths may press down the soft palate so that it can no longer close the passage to the nose. A leakage of the expired air is thus produced; and the child's speech sounds rather like that associated with cleft-palate, though the nasality is seldom so marked: in such a case removal of the growths is usually of itself sufficient to restore the soft palate to normal action. Secondly, however, the growths may be so large as to block the passage completely. Here nasal sounds are prevented, not produced: 'coming' and 'running' are pronounced like 'kubbig' and 'ruddig,' and a dull heaviness obscures almost every tone. In these cases an operation may be insufficient. The palate has remained unmoved so long that the muscles have grown weak through disuse. Systematic practice, along the lines I shall describe in a moment, is requisite to strengthen muscular control.

At times, a mere sore throat or a nasal catarrh will render the production of certain sounds difficult and possibly painful; then, after the acute condition has subsided, the mispronunciation may still linger on as a habit. In 13 per cent. of my cases chronic catarrh was actually noted or reported. Occasionally excessive salivation, due to infected or over-active glands, interferes with sibilants. All such troubles, when present—swollen adenoids and tonsils, infected glands, and thickened nasal bones—should first be properly treated; but special exercises will often be as essential as medical treatment; and usually it will be wise to keep the child protected from chill and catarrh, which are very liable to revive the old habits.

Tongue trouble, in the literal sense, is far less important than is popularly imagined. This is one of the many instances in which the uninstructed mind is apt to take a traditional metaphor *au pied de la lettre*. At times a large tongue—as seen, for example, in many Mongolian defectives

—may help to make the child's utterance thick and indistinct. A broad tongue will render fricatives difficult. A long tongue will tend to produce *th* instead of *s*. 'Tongue-tie' is repeatedly blamed by mothers; but, once again, they are taking a figurative phrase for a precise anatomical description. Occasionally, it is true, an actual shortness of the *frænum linguæ* (the membranous fold that keeps the tongue tied down from below, so that it cannot be raised very high or protruded very far) may hinder the formation of sibilants, and generally make clear utterance a little difficult; but it can seldom make it impossible. Even in the worst cases, the tip, with an effort, can still be pressed against the upper teeth; and nothing more is needed for most articulatory purposes. A cultured friend of mine is so tongue-tied (in the literal sense) that he cannot put out his tongue for the doctor's inspection, or place a thermometer beneath it: yet this has in no way interfered with the development or plainness of his speech; the sole result is a faint tendency to burr his *r*'s—as a Parisian or a Northumbrian might; that is, he gurgles them with his uvula, instead of trilling them with the tip of his inflexible tongue.

(5) Gross physical malformation, however, though often assumed to be present even by the medical specialist, is, in point of fact, by no means frequent, and is usually a provocative rather than an essential cause. It should always be looked for, and, so far as possible, corrected. But much more frequently the main difficulty arises, not from an imperfect shape of the organs, but from an imperfect command over the muscles that move them. The child suffers from a kind of *motor deficiency*, either widespread or specific. This was noted in 17 per cent. of my cases.

Sometimes all the child's movements seem coarse, careless, and inaccurate; and in many instances the clumsiness, both of speech and of action, appears to be little more than a sort of general physiological indolence—a lack of energy, a want of muscular promptness and briskness, that betrays itself in conversation by a slow, slurred, slovenly, and monotonous mumble. As already noted,[1] many left-handed stutterers are also of this type; but it is not so often

[1] See above, p. 288.

recognized that both clumsy handedness in general and left-handedness in particular are almost as common among children who lisp and lall. As many as 11 per cent. in the group I investigated proved to be definitely left-handed.

In others the muscular awkwardness seems more limited and specialized. Weak mouth control is very characteristic of children with imperfect articulation, and is sometimes revealed by a tendency to dribbling and excessive salivation. Occasionally there may even be a definite local paresis: after diphtheria, for example, the muscles of the palate may be left paralysed or weak, and many of the posterior consonants get muffled as a result. More often it is the whole co-adjustment of simultaneous speech-processes that constitutes too delicate and complex a feat for the maladroit speaker to carry through. Just as some can never help fumbling when they use the finer muscles of their fingers, so others seem born fumblers with the muscles of their vocal organs. The elaborate combination of movements to be made, and of postures to be taken, by mouth, nose, throat, and lungs, all nicely timed and correlated from within, with little or no assistance from sight, forms an achievement of unusual subtlety; and in an articulative apparatus so intricate and refined some tiny derangement of its neat co-ordination may easily occur, and give rise to the grossest flaws of enunciation and speech.

(6) Sometimes, however, the real cause of the trouble lies not in the muscular machinery itself, but in the ear that guides and governs it. Careful testing may reveal some form of *auditory defect*, often hitherto missed because of its mild or unfamiliar nature. Of my own cases, 8 per cent. suffered from slight deafness; but in 5 of the 8 per cent. the deafness was much more marked for the notes of higher pitch, and, indeed, with tests of the ordinary type would hardly have been recognized at all. In another 15 per cent. defects of auditory discrimination (unaccompanied by any obvious deafness in the usual sense and apparently lying in the central mechanisms for perception rather than in the local mechanisms for sensation) were revealed by more extensive study.

Just as the totally deaf, unless specially taught, grow up

dumb as well, so the partly deaf are likely to become indistinct speakers, simply because they seldom hear, with any degree of clearness, either their own speech or another's. In the milder cases, since both motor and auditory defects produce much the same results (a slight slurring of certain consonants), it is not easy to tell, without systematic testing, which cause is predominantly at work. In cases more marked, the nature of the consonants affected and the character of the substitutions employed will often help to distinguish the two causes.[1] Not infrequently, too, the child whose trouble springs mainly from his hearing shows typical mistakes in dictation as well as in speech. The characteristic errors are, first, a tendency to miss syllables which are unaccented, and, secondly, a frequent confusion between syllables containing similar vowels but different consonants. For example, one of the children in this group wrote: 'He has got his gloves' for 'Henry is off to the club.' In the severest cases of all the speech itself nearly always reveals other peculiarities besides defects of articulation: the child talks in a flat monotonous tone; the rhythm of his sentences seems lacking or strange; the inflections of the voice sound unnatural, exaggerated, or curiously mechanical.[2]

But, at any rate in the ordinary elementary school, a cause far commoner than sheer dullness of hearing is a coarseness of auditory discrimination—a difficulty in perceiving, not the intensities of sounds, but their qualities. Faint noises from a distance the child may catch quite as well as the normal; but he fails to discern the finer shades of difference between one noise and another—for example, between *p* and *b* or between 'three' and 'free.' Such a child may be able to imitate the correct movements with his lips, so long as he is looking at his teacher, or watching

[1] For details see Appendix IV, and compare Fig. 6 above, p. 246.

[2] Some of these symptoms at times arise indirectly from the way the child has been taught to speak. My colleague at University College, Dr. Phyllis Kerridge, has secured gramophone records illustrating the various characteristics of speech-defect to which deafness of different degrees may give rise. For a detailed description of some of her cases (children from a London School for the Deaf and Partially Deaf) see 'Speech Defects and Deafness,' *Speech*, October 1935, pp. 1 *et seq.*

his own face in a mirror; but, when he relies upon his ear instead of his eye, he becomes quite powerless to recognize, from any sound he himself is producing, whether he is still mispronouncing or no.

In many of these cases the defect turns out to be peripheral after all. The simplest cause seems to be a kind of high-note deafness such as I have already described in detail. This, as we have seen, renders the child more or less deaf, not to every tone, but only to those of higher pitch, and even so is seldom uniform or complete; without special apparatus, therefore, it is likely to be missed altogether.

In the more extreme cases,[1] the tiny child who is afflicted in this way may remain almost completely dumb: probably he will at first be taken for a deaf-mute; then, when it is found he can hear common noises, he may be diagnosed as a case of aphasia. Or the child may ultimately attempt to speak, nearly always at a very late age, but will develop an idioglossia; the clergyman's son, whose speech I have transcribed above, proved hard of hearing for nearly all the notes in the treble clef and almost totally insensitive to higher notes still.[2]

In slighter cases the sounds most commonly mispronounced are the fricative consonants. Voiceless *s*, *f*, and *th* are frequently confused; and sounds such as *s*, *sh*, *ch*, especially at the beginnings and ends of words, may be omitted altogether. In the investigation of 31 cases of lisping, referred to above, I found evidence of a high-note deafness in no less than nine: three were definitely unable to hear any note above 6,000 v.d.—the region of the hissing note of a sibilant *s*. Many adults seem unable to perceive that most loud-speakers in ordinary use never render an *s* with accuracy, and give every broadcaster a definite lisp. Those who have tried to teach French vowels to English

[1] See p. 251, above.

[2] Dr. Ewing describes the case of a child of 10, suffering from high-frequency deafness, who, at the outset of her teaching, 'developed a jargon' apparently not unlike that of the idioglossic: *e.g.* for 'do be careful' she said 'meemi hairful'; for 'put it upstairs' 'pukky upkay' (*Aphasia in Children*, p. 65).

students are often astonished to discover that a number fail altogether to hear the difference between a French *é* and an English *ay*, or between a French *i* and an English *ee* —differences that turn partly on high-pitch components[1]; and I believe that not only the downright defects of many lallers and lispers, but also the ineradicable bad accents and mispronunciations of those whose speech is otherwise normal, may often be related to their poor power of discriminating overtones and timbres.[2]

In many cases, however, the child's hearing for simple tones, of whatever pitch, seems perfect. The difficulty appears rather to arise in discerning the differences between them, and in analysing sounds, and sequences of sound, that are at all complex. For reasons that I need not specify here, the failure seems to lie at a higher level than that of

[1] Compare the example of high-note deafness described above in the chapter on auditory defects (pp. 251–2, and Fig. 8). The rarer instances of low-note deafness (cf. p. 251) tend to manifest speech-defects of a somewhat different kind: as might be expected from the sound-frequencies involved (cf. Fig. 6), the consonants which are then most easily omitted or confused are the continuants *m*, *n*, *ng*, *l*, and *r*. Thus, an intelligent boy of 14 (M.R. 112), who was later found to be almost completely deaf to sounds below a vibration frequency of 400, habitually pronounced 'Jim' as 'Jill,' 'gin' as 'jim,' 'singing' as 'sinnin''; for 'Christians' he read 'crystals' or 'cristiaws,' and for 'Belgians' 'Belgiums'—mistakes which may often be heard in those who are not suspected of partial deafness: all other consonants he pronounced correctly. The speech of such a patient is often weak in low tones, and sounds high-pitched, thin, and reedy. But partial deafness confined chiefly to low notes is decidedly unusual.

I may add that in my work with intending secondary school teachers at the London Day Training College I found that several students reported as having an incurably bad French accent seemed to suffer from a mild form of high-note deafness. A similar difficulty was apparently encountered in trying to teach a good English accent to those who preserved a cockney or provincial speech. It is noteworthy that women students pick up a 'public school accent' far more easily than men students from the same social class: the sisters nearly always speak better than their brothers. And, as I have shown in an early research, pitch discrimination is far weaker among boys and men (see Whipple, *Manual of Mental and Physical Tests*, I, p. 217). No doubt, however, this is by no means the only sex-difference at work.

[2] In an earlier publication I have given a detailed study of a case where backwardness in reading was associated with a defect of auditory discrimination and speech, in a child whose auditory acuity, as commonly tested for faint sounds, appeared perfectly normal (*Mental and Scholastic Tests*, p. 286).

mere sensory perception—to be mental rather than physical, or (to use a slightly more accurate distinction) cerebral rather than peripheral.

The importance of factors such as these seems confirmed by the fact that many speech defectives, without being actually deaf or unintelligent, are nevertheless very obtuse in understanding speech—'slow in the uptake,' as the teacher observes. In addition, they frequently seem destitute of all musical talent. They sing their little hymns and nursery rhymes with no notion of the melody. They can barely distinguish one note from another, 'Rule, Britannia' from 'God Save the King,' or the tones of a reed-instrument from those of the strings on a violin. Like Charles Lamb, a notorious speech-defective, they 'have no ear for music, and are organically incapable of a tune.'[1]

(7) The ear, however, is not the only sense that governs the movements of speaking. Like all other muscular activities, speech is largely controlled by the muscle sense. The part played by this obscurer sense in guiding articulatory movements has hitherto been almost entirely neglected. Its importance is more easily distinguished when the pupil is learning to sing or to speak a foreign language than when he is speaking his mother tongue. No doubt, what I have described above as lack of motor dexterity is due quite as often to a *weakness of the kinæsthetic* sense as to a weakness of motor control. At present we have no adequate tests for distinguishing the two.

(8) Nor is it merely a weak sense-perception, whether auditory or kinæsthetic, that may be chiefly to blame;

[1] *Essays of Elia*, p. 52. The teacher is a little too apt to diagnose 'tone-deafness' from the mere fact that a child cannot sing. In almost every class, particularly in a boys' department in a poor neighbourhood, there are one or two individuals who sing hopelessly out of tune, usually converting the melody into a mere monotone. In such cases the commonest cause of all is not tone-deafness, but some form of nasopharyngeal trouble, which often betrays itself in speech as well by a chronic huskiness, a nasal twang, or a thick and indistinct utterance. This may at times be accompanied by a general intermittent deafness; but often acts directly by impairing the muscular organs.

weak imagery may also play some part. For example, with many students trying to produce the sounds of a foreign language, it can often be shown that, so long as they actually hear the correct sound, they easily perceive how it differs from their own; but when they are left to call up the correct sound in the mind's ear, as it were, the resulting memory-image is too faint for any clear difference to be perceptible. Much the same sort of vagueness over the actual nature of the correct sound seems often to hamper the speech-defective's efforts to improve his pronunciation of his own mother tongue. With those who depend on motor imagery rather than auditory, it may be at times discovered that their preliminary images of what they are about to say—a kind of muscular trial in imagination of the movements and positions their lips and tongues are to make—are too unreliable to act as an efficient guide.

With older students such influences may constantly be verified by getting the speaker to introspect. With young children it is much harder to gain an insight into these subtler methods of control. There can, however, be little doubt that the slowness which young speech-defectives exhibit in understanding speech, as well as in pronouncing it, is often due, not to the simple sensory or motor difficulties most commonly noted, but rather to their defective verbal imagery—particularly to a poor kinæsthetic memory for speech movements. Speech specialists, it may be observed, as well as ordinary teachers, are too apt to assume that the memory-images of speech-sounds are exclusively auditory; with children they are, in all probability, far more frequently kinæsthetic or 'motor.' This is a point which, as we shall see later, bears almost as much upon the teaching of reading and spelling as upon that of clear speech; and it will often be found that a similar psychological condition —a defect in word-memory—lies at the root of both troubles.

These, then, seem to be the commoner causes of mere articulatory defects, and these are the points to which the investigating psychologist or teacher should specially direct his attention.

Cleft Palate and Nasalized Speech.—A distinctive crop of mispronunciations is met with in one well-known deformity of the mouth to which I have already referred—cleft palate; and, in a milder form, much the same peculiarities are sometimes found in the dull Londoner from the slums. Improvable as they are, and yet all too frequently neglected, these mispronunciations require a supplementary word of explanation.

There are, in point of fact, two palates, and not one, as anyone may ascertain by feeling or looking at the roof of his own mouth. The front part is hard and bony; the hinder part is soft and muscular. Either or both may be 'cleft,' and remain unduly open from birth. The deformity leaves a permanent opening, leading from the throat and back of the mouth into the back of the nose. Hence, the child suffers from a genuine rhinolalia, *i.e.* speaking through the nose.[1]

Almost identical mispronunciations may at times be heard in children whose palates are perfectly normal in shape. Here the trouble is, not that the roof of the mouth is perforated, but that the flexible flap at the back of it is not under effective muscular control. For example, the slum-child, owing to the mild but chronic catarrh from which he suffers, often finds it difficult to breathe through the nose: he feels he can do so more freely if the entrance at the back is left permanently open. Consequently, when he speaks, part of the stream of air always passes through, or at any rate into, the nose. This perhaps is the commonest cause of

[1] Theoretical writers distinguish between what they term *rhinolalia aperta* ('open nasal speech') and *rhinolalia clausa* ('closed nasal speech'). The former they attribute to an open nasopharynx (as in cleft-palate speech), the latter to a closed nasopharynx (as in nasopharyngeal obstruction by adenoids and the like). If the contrast is to be pressed, the latter should be called not 'closed nasal speech' but 'closed-nose speech,' since in itself it is not nasal but denasalized. Actually, however, as noted in the text, when the nose is blocked by catarrh or adenoids, there is often a semi-reflex tendency to try to open it, by keeping the soft palate down. Thus, even when the nasopharyngeal passage is organically closed (towards one end), it is kept functionally open (at the other end), and so a nasal timbre is frequently produced, though nasal consonants sound partly denasalized. Thus the commonest form of so-called rhinolalia is neither purely 'open' nor purely 'closed,' but 'mixed.'

what is sometimes termed 'functional rhinolalia' as distinct from 'organic.'[1]

In children whose palates, for one or other of these reasons, fail to close properly, a systematic study will show that the commonest and most characteristic mispronunciations are the following. First, the vowels, especially when they come before nasal consonants, are pronounced with a peculiar twang. Every visitor to London knows the cockney newsboy's nasal cry—'maĩpə' (for 'paper'). A similar nasalization is characteristic of certain American and colonial dialects. Secondly, the fricative consonants are accompanied by a nasal resonance so strong that the oral friction is inaudible: *f*, *v*, *th*, *s*, *z*, and *sh*, all degenerate into a kind of snort which more or less resembles an unvoiced *n*. Occasionally the child attempts a fricative effect in the pharynx instead of in the mouth—a throaty scrape, like a badly-made uvular R. Thirdly, the plosives become impossible, because the air passes out through the nose instead of being stopped in the mouth; thus *p* and *b*, *t* and *d*, *k* and *g*, become

[1] No doubt, in many cases, the soreness and the inflammation at the same time make it difficult to move the fleshy trap-door which should close the passage. But there are a number of different causes which may lead to the so-called 'functional' type of rhinolalia. The simplest, but by no means the most frequent, would seem to be motor deficiencies of the type described above (p. 385)—for example, a general muscular weakness such as is common in debilitated children, or a mild paralysis of the palate, such as occasionally follows diphtheria, tonsillitis, and other infectious fevers.

When adenoids have been removed, the parent often complains that the child's speech is worse. Here the apparent aggravation is generally due to the prolonged disuse of the soft palate or the prolonged attempt to keep it open during the previous state of obstruction. This tendency persists after the operation; and, owing to the removal of the blockage, the resulting nasal resonance now sounds more marked. A 'functional' form of rhinolalia thus remains. The condition can, as a rule, be easily remedied by appropriate exercises.

In cases diagnosed as 'organic' the part played by the physical deformity may easily be over-estimated. One of the most striking I have encountered was that of an adult suffering from severe cleft palate which would ordinarily have been thought to demand an operation; indeed, he had been told by his own doctor, and by two surgeons independently consulted, that his impediment was otherwise quite incurable. After six months with an elocutionist, he was able to overcome all the characteristic symptoms, except a slight nasality.

voiced or unvoiced *m*'s, *n*'s, or *ng*'s: sometimes instead of a plosive the child uses a glottal stop, because the glottis is the only place where he can make a stop and a plosion. Both in London and in Glasgow you may hear such elisions as 'bo'le of wa'er' or 'lu'y cou'le' [1]; the spelling of Burns [2] and the patter of the comic Scot upon the stage perhaps provide the most familiar illustrations. At school the speech of these children is often left uncorrected, because they are supposed to be suffering from some anatomical malformation which nothing but the surgeon's sewing-gut will remedy; whereas a little conscientious training will quickly give them all the control they need. The proper methods I shall describe in a moment.

II. Stammering

Methods of Investigation.—The preliminary examination of the stammerer, like that of the child who lalls or lisps, will be directed towards two main points. It will include, first, an inquiry into the specific form of the disturbance in each individual case, and, secondly, an inquiry into its remoter causes. The causes, however, for which we mainly look will depend on the theory we have adopted of the general character of the defect; and in my opinion the current conceptions of stammering fail to recognize its manifold nature. Not only does it take many different forms and types, but it is also provoked by many different conditions. It is thus not so much a single specific disorder in itself, as a symptom belonging to a whole group of disorders.

Whereas lalling merely consists in the failure to acquire certain normal speech-sounds at the natural time, stammering generally originates as a positive and intercurrent neurosis, supervening after normal speech has been achieved. Those who lisp or lall have not yet learnt to speak perfectly; those who stutter have usually spoken fluently at first, and then at some definable date have suddenly produced an unexpected impediment. Thus, the elocutionists who first inquired

[1] *I.e.* 'bottle of water' and 'lucky couple.' The apostrophes indicate, not true elisions, but the substitution of glottal stops, for which the ordinary alphabet has no symbol.

[2] 'Na' for 'not,' 'wi'' for 'with,' 'an'' for 'and,' 'fu'' for 'full,' etc.

into the special causes of stammering early realized that it was in its essence an acquired *habit*; medical writers, in view of its apparently pathological nature, have more recently added that it must be a *neurotic* habit—a sort of nervous tic. Accordingly, while they ascribe the more obstinate defects of articulation to physical or mechanical conditions, stammering they attribute almost exclusively to nervous or mental conditions; in fact, they have unanimously classed it as a typical 'functional' disorder; and the causes which they cite as leading up to it are much the same as those that are believed to generate other forms of neurosis.

If, however, we stop short with this current account, we are left with the puzzling question to which I have already alluded: why, in these particular individuals, does the neurosis manifest itself primarily through a disturbance of speech? After all, most neurotic patients do not stammer. And too often the psychiatrist seems content to demonstrate that the stutterer is in fact suffering from a neurotic disorder, and to deal with this disorder along general lines, regardless of the peculiar speech-habit which the neurosis has brought in its train.

Causes.—With stuttering, therefore, as with lalling, we can usually, if we look for them, discover causes of two kinds: first, an emotional or intellectual maladjustment, fairly general in its nature; secondly, a predisposing weakness, often apparently inherited or innate, affecting more specifically some part of the sensori-motor mechanisms for speech, and so determining the direction in which the outward symptoms manifest themselves. Earlier writers emphasized the latter factor almost exclusively, and treated stuttering as though it were a mere physiological disorder to be cured by muscular exercises. Recent writers have emphasized the emotional factor almost exclusively, to the neglect of the remainder. But even the union of both explanations is to my mind scarcely comprehensive enough.

In my view stuttering is a disorder affecting the whole function of speech, although in different types of case different elements in the total function may be disturbed more seriously than others. Speech is essentially a mental

activity, and as such includes three main aspects. First, and most obviously, it involves a skilled *motor* process, a complex series of movements brought to a high state of mechanical perfection as a result of repeated practice. Secondly, these movements are always guided by *cognitive* control: the thoughts expressed in speech, the words used to express them, the correct enunciation of the words, all this is directed by intellectual and perceptual processes, swift and elusive, and therefore often overlooked. Thirdly, speech is motivated, and may readily be disturbed, by *emotional* processes, particularly by emotions connected with the self that is expressing the thoughts and with the persons who are to receive and react to them; in a word, by what we may loosely designate self-consciousness and social consciousness respectively. Each of these aspects is apt to be affected in the stuttering child, and each must be investigated in turn.

Immediate Causes: Motor Factors.—As a motor process, speech involves a delicate co-ordination, simultaneous and successive, of three neuro-muscular mechanisms—respiratory, vocal, and articulatory. The immediate cause of the stammer is a kind of muscular cramp or convulsion overtaking one or more of these three mechanisms and so impeding the continuous rhythm of speech. Thus, if we classify stammerers according to the outward nature of the stammer, we can recognize several different forms. The involuntary contractions of the muscles may be either tonic or clonic, and may affect either the muscles of the chest and abdomen, or those of the glottis, or again those of the lips and tongue. In most instances an excessive activity of the articulatory muscles appears to be the primary cause; but the interference with the current of air from the lungs seems responsible for the more conspicuous consequences. The general result is that when the child has to stop his breath in the mouth he also stops it either at the vocal cords or in the chest.

In these cases the process may perhaps be explained on the principle of 'inhibition by drainage.' When one system of neuro-muscular mechanisms is over-active and so dominates over the others, the others may fail to function altogether.

Thus, if the child's attention is mistakenly concentrated on the process of articulation, this may divert energy from the mechanisms that control the other movements, and a spasmodic arrest may ensue. Generally, the arrest does not simply consist in a complete cessation of muscular activity. It is due rather to a partial inhibition of the more delicate controlling mechanisms, so that spasmodic contractions, sustained or intermittent, take the place of contractions that should be more delicately graded and timed. The higher cortical control is abolished, or rather directed elsewhere, and more primitive reflexes—violent, isolated, and local, as such reflexes usually are—seem to be allowed free play.

Before we can suggest appropriate exercises to correct these neuro-muscular defects, it will be necessary to consider, in each individual case, what special types of movement are apparently baffling the speaker. As a rule, though by no means invariably, the stammering starts at or near the beginning of a fresh phrase or sentence ; most frequently it occurs before the first accented syllable of the first emphatic word—the word, that is, on which energy and attention are focused. In early cases the stumbling block is commonly an emotional word, or a word whose significance is crucial to the sentence, or again a word about whose correctness the child is somewhat uncertain. In later cases, where the stuttering has grown into a habit or an obsession, it seems rather to be some slight mechanical difficulty over pronouncing particular sounds that regularly precipitates the spasm, for example, a ' plosive ' consonant (or 'stop') at the commencement of an accented syllable.

To make such consonants, all that is really necessary is momentarily to close the mouth—either with the lips (as for *p* and *b*), with the tip of the tongue (as for *t* and *d*), with the back of the tongue (as for *k* and *g*), or with the glottis (for the glottal stop that often precedes initial vowels). The closure is exceedingly brief. Hence there is no need to stop the current of air itself. The stammerer, however, mistakenly checks at the same time what should form a continuous expulsion of air from the lungs ; and his efforts to overcome this extra and unnecessary stoppage give rise to the more obvious symptoms. In some cases

the chest and diaphragm seem suddenly to stick; in others they are thrown in forcible contraction, and the child gives the impression of trying to blow through a tightly shut glottis. In the more advanced cases the reiterated efforts themselves set up a rhythmic succession of convulsive movements. The breath is expelled in jerks; the oral 'stops' are rapidly repeated; and the repetition of the sound produces the audible stutter.

What, then, are the particular sounds which are most likely to cause such difficulties and therefore require to be watched during the preliminary examination of each case? A few statistics may serve as a guide. From their very nature, consonants are by far the most troublesome. All consonants may be classified either according to the mode or according to the place of their formation—that is, according to the manner in which they are articulated (explosively or continuously, with or without voice), or according to the organs moved in articulating them. From the former standpoint, those that most frequently start a blockage are consonants requiring a stop followed by a voiceless explosion—*p*, *k*, and to a less extent *t*: in 82 per cent. of my cases these caused the chief trouble. This no doubt is due to the fact that in order to produce a voiceless consonant the vocal cords have suddenly and momentarily to be closed. The voiced plosives, *g*, *b*, and *d*, are not so harassing, and provided an occasion for stammering in 57 per cent. of the cases. The stronger fricatives—*s* and *h*—also seem awkward sounds for some people: *s* is a voiceless fricative, and is apt to precipitate a stutter in those who have difficulties with other voiceless sounds; *h* is a glottal fricative; but here the stutter appears rather to arise from spasmodic movements of the diaphragm and of the respiratory muscles generally. Of the other continuants, *m* and to a less extent *n* sometimes produce a coarse trembling of the lower jaw, and with it of the lips or tongue. Stammering over these four sounds—*s*, *h*, *m*, or *n*—was observed in 24 per cent. of the cases. Stammering over other consonants was noted but rarely, namely, in 13 per cent. Stammering before vowels was noted in 17 per cent. of the cases. Stammering before a vowel, however, is nearly

always stammering over a glottal stop, which is strictly a consonant. This usually occurs before back or semi-back vowels. Before front and close vowels, such as *ee* or *ay*, it is comparatively infrequent.

With many children the cramp or spasm occurs only when the vocal organs are in certain positions. In my own cases, on cross-classifying the troublesome letters (or rather sounds) according to their place of formation, the frequencies proved to be as follows: first stop position (between the lips, as for *p*, *b*, and *m*), 58 per cent.; second stop position (between the tongue and teeth, as for *t*, *d*, and *n*), 32 per cent.; third position (between the palate and the back of the tongue, as for *k* and *g*), 41 per cent.; fourth position (the glottis, which may be closed simultaneously with a closure at other points), 21 per cent. A glottal stammer is the hardest to detect, particularly when it accompanies a spasm in other positions: hence the figure just given may possibly be an under-estimate. The relative infrequency of stammering in the second position is doubtless due to the fact that here the closure is weakest.

Remoter Causes.—If the teacher makes a preliminary examination along these lines of the precise nature of the motor process in each individual stutterer, the results will be of considerable help when he comes to devise appropriate methods of training. But before attempting to cure the defect by the simple plan of reiterated exercise, it will be wiser to inquire first of all what remoter causes have favoured the habit, and are still perhaps helping to maintain it.

Some light may be thrown on the nature and importance of the different factors by a rough statistical analysis of a sample set of cases. From the records of children who have been referred to me on one ground or another, I have sorted out all those who have been afflicted with a stammer. They amount to 97 in all—76 boys and 21 girls. The group is small. But it will suffice to illustrate the difference in frequency between the causes commonly cited; and the individual case-histories often serve to reveal how the various causes operate.

(1) *Innate or Hereditary Factors.*—A neuropathic inherit-

ance was found in as many as 62 per cent. of the cases ; and in 23 per cent. a tendency to stutter was reported among the child's relatives. Where one of the parents or where an elder brother or sister is noted as stuttering too, imitation rather than heredity may, of course, have induced the stutter in the younger child. Imitation, however, is much rarer in stammering than it is in defects of articulation ; and, in 14 out of the 23 per cent. just mentioned, the child had never been in contact with the relative who stuttered.

In as many as 92 per cent. there were concomitant signs of an unstable nervous system, or of a temporary nervous disorder, or of both—habit-spasms, night-terrors, nocturnal incontinence, convulsions during infancy, fussiness over food and clothing, petty delinquency, excessive excitability, and the like. 32 per cent. of the children had been late in learning to talk, and 15 per cent. were subject to lisping or lalling in addition. 14 per cent. of the children were left-handed, 5 being mirror-writers ; and in 18 per cent. a history of left-handedness was reported in the family, although, in some of these instances, the child himself was not left-handed. I have already emphasized, however, that stuttering, like other speech-defects, is associated quite as much with a general clumsiness and inco-ordination of the hands as with left-handedness specifically as such.[1]

[1] The left-handedness was chiefly noted either among stammerers of an openly assertive disposition, or among those of a repressed but secretly rebellious temperament. As we have seen in the preceding chapter, teachers commonly believe that, since in the brain the ' speech-centre ' is placed near the ' centre ' for voluntary movements of the right hand, therefore forcing the left-handed child to use his right may precipitate a stammer. It may ; but not for the reason supposed. It operates, as I have already shown, just like any other strain at school ; the constant checks, corrections, and rebukes, may provoke, in the highly-strung child, nervous symptoms of almost any childish type. Here it is necessary only to summarize what I have said above (pp. 323 *et seq.*) : stuttering is associated, not so much with the right-handed training of the left-handed child, but first of all with left-handedness itself, this being, like speech-defect, but one of the many forms in which motor inco-ordination may manifest itself, and secondly and still more closely with the particular methods by which in the past the right-handed training has been carried out, namely, methods involving constant criticism, repression, and strain. If the training is tactfully and sympathetically undertaken, no ill-effects are likely to result.

The average intelligence was practically normal (mean mental ratio, 97). There seemed to be an undue number of children definitely above or definitely below the average: 17 per cent. had mental ratios below 85, 22 per cent. had mental ratios above 115.

(2) *Physical Conditions.*—As with other nervous disorders, mild ill-health or definite disease seemed often to have marked the starting-point. If a period of debility occurs when the child is beginning to speak, then speech, as we have seen, may be merely delayed or interrupted; but if it occurs just after this stage, then positive speech-defects are liable to ensue. In 8 per cent. of my cases the stammer apparently came on after some acute and febrile illness—measles, whooping-cough, pneumonia, diphtheria, or the like; both whooping-cough and diphtheria, it may be noted, at times leave behind them a disturbance of the muscular adjustments of the throat or chest (*e.g.* a paralysis of the palate after diphtheria and a diaphragmatic tic after whooping-cough). In another 11 per cent. the stammer appeared during a spell of physical weakness due to vaguer and more various causes—in some cases to what had been officially described as anæmia, or perhaps to a sudden deprivation of fresh air and exercise after the child's family had removed to an overcrowded town, or again when the child himself changed for the first time to the unhealthy sedentary life of an old-fashioned school. Adenoids were present, or had been present, in 31 per cent. of my cases, enlarged tonsils in 19 per cent., irregular or defective teeth in 13 per cent., though, except in one or two instances, it was doubtful whether these troubles were serious enough to interfere with ease of speaking. In a few instances I have noted that lalling or lisping (the latter often arising from dental malformation) seemed of itself to have led to a stutter: the child had become conscious of a difficulty in pronouncing some particular consonant correctly, and had started to stutter with that particular sound. In one or two cases of transitory stuttering, some mild gastric or abdominal disorder seemed to be disturbing respiration. I may add that in the rare instances in which physiological causes seemed more im-

portant than emotional the trouble took the form of a stammer rather than a stutter—*i.e.* of a tonic rather than a clonic (or reiterated) spasm. As a rule, the physical conditions appeared to be no more than contributory, although at times their removal seemed appreciably to accelerate the cure.

(3) *Emotional Factors.*—In the vast majority of cases the real cause is mental rather than physical. Usually the stutterer is an emotional child, shy, sensitive, and self-conscious, with marked tendencies towards anxiety and repression. Fear is the emotion with which the habit is associated most closely—particularly social fear: stuttering is a sort of shuddering or trembling in the speech. This is the impression very clearly conveyed by the small, apprehensive infant, whose timorous protests often come in inspiratory instead of expiratory spasms; in his dismay you may hear him almost sob: 'I—I—I—I didn't-do-it-mummy!'—sucking in his words rather than bringing them out. Terror, more than any other instinct, interferes with respiration and speech, producing rhythmical gasps and cries, or entirely choking all utterance for the moment.

It is quite conceivable that fright may genuinely precipitate a stammer; and in at least 6 per cent. of my cases the trouble was dated by the parent from a definite mental shock. Often, however, when such stories are carefully sifted, it will be found, not that the fright of itself directly engenerated the stammer, but rather that the child's endeavours to speak *during* the fright sowed the first seeds of the habit: his efforts at that impressionable moment seem to have set up a deep and lasting association between any attempt at speech, on the one hand, and an overpowering fear, on the other—a fear which brings with it the usual respiratory disturbances. A boy, just learning to talk, is knocked down by a cart; his mother picks him up, and asks: 'Are you hurt?' Her alarm intensifies his own; and if, while the automatic working of the speech-mechanism is still out of gear, she insists on a reply, the boy is likely to stammer, and the stammer may possibly stay.

At a later age, sustained worry and anxiety seem frequently

responsible for the trouble—coming to a strange school, for example, or to a senior department. Yet at times the child's fears are quite as much a result as a cause: there may have been so much chaffing and teasing, and so much notice centred on the boy's misfortune, that any speech-sound offering the slightest difficulty becomes the focus of a phobia; and his momentary panic makes him stutter worse.

The stutterer, however, is not always of a conspicuously timid type. An assertive, domineering boy will sometimes produce a stammer, which is usually manifested only in certain situations—for example, when he is in conflict with authority. He may perhaps never hesitate except when an older person is present. Or he may stammer in class but never in the playground, or only at home and never with strangers. Some will stumble only over emotional words or references—to which, nevertheless, they may seem somewhat addicted—particularly those that are commonly tabooed. A bright and excitable youngster of five began to stammer soon after the birth of his little brother. When he was brought to me, I asked him how he liked the baby. He jerked out: 'Oh, he's b-b-beautiful, thank you'; and, turning to his mother, at once added: 'I didn't say it, mummy, did I?' 'It' (so his mother explained) was the word 'beastly'—a word which she had always checked, and one which the boy had been rather prone to apply to other children, though, so far as she knew, he had never openly used it of the baby. In such cases the hesitation, like so many neurotic symptoms, represents a compromise: it is a compromise between defiantly saying, and pointedly not saying, the forbidden phrase.[1]

[1] Such explanations sound somewhat far-fetched and fanciful, and perhaps are not often warranted. Yet every psycho-analyst will be familiar with similar processes from his own clinical experience. Dr. Melanie Klein, for example, relates that one day a little friend of mine whom she was psycho-analysing for this trouble—a girl of 7—faltered out: 'I sh-shouldn't think of doing such a thing.' When asked why she stammered, she explained: 'The first "should" was the one I shouldn't, and the second was the one I should.'

A girl of 15 who came under my care frequently stammered over the letter *b*, and no other. After a little analysis, she suddenly explained that, when she first began to hesitate in this fashion, she was always afraid she might say by mistake 'a bad word beginning with *b*.' Then, to my surprise, she gave

The youngest stutterers of all are often sharp, responsive, animated little creatures—children who understand language long before they can use it, and whose ideas seem to rush to their lips more rapidly than their unpractised mouths can tumble them out. They suffer from what some writers have called 'cluttering' and others *agitophasia* or *logorrhœa*—apparently implying by such terms a kind of verbal incontinence, a profuse and agitated discharge of words.[1] Such children pour forth their chatter with a

examples, boldly ejaculating a long list of expletives, all beginning with *b*—from 'bother' downwards; and never stammered again!

[1] The various terms are not quite synonymous; and the conditions they describe may occasionally be observed in children who do not stutter. Hence German writers have distinguished a separate form of speech-defect, to which they apply the suggestive name *poltern* (*Polter*, 'a blustering fellow or bully'; the verb is more commonly used in the sense of 'knocking or tumbling things about'; cf. the *Poltergeister* who have attracted the attention of the Society for Psychical Research). *Logorrhœa*, which literally implies simply an unrestrained flow of words, is a more general expression. Some English writers, *e.g.* Seth and Guthrie, treat the two terms as identical. But the German word implies something more than mere excessive frequency and speed: it describes a form of utterance in which, owing presumably to the speed being too great for the child's powers of co-ordination, the words become so slurred, curtailed, and clotted up, that the sentences are almost unintelligible. *Agitophasia* is a term introduced by American writers to describe something of this sort (J. S. Green, *New York Medical Record*, 1916, p. 754). 'Cluttering,' a word adopted by writers in this country, seems plainer and more apposite: (the verb is connected with 'clot'; the Yorkshireman uses it of an overcrowded room; Tennyson uses it of the Devil's goose—

It clutter'd here; it chuckled there;
It clacked and cackled louder).

As the German term suggests, the 'Polterer' or 'clutterer' is more often of an assertive than of an inhibited temperament; the anxiety symptoms, so characteristic of the ordinary stutterer, are seldom present. This, indeed, is equally true of cases of logorrhœa generally. In those that I have encountered, particularly among older children, there has frequently been reported, in addition to the mere volubility of tongue, an unrestrained impulse to scribble in copybooks and scrawl on walls. Other symptoms of neurotic instability are nearly always found, and, very often, a history of incontinence in the literal sense. Cluttering itself, as distinct from mere logorrhœa, is rarely observed in elementary schools or during the elementary school period; Kerr, indeed, concludes that it is probably less frequent in this country than in Germany. It is, however, by no means uncommon during the pre-school stage and again during adolescence.

rush and a jerk; and so (in Rosalind's phrase) 'stammer . . ., as wine comes out of a narrow-mouthed bottle; either too much at once, or none at all.'[1]

Often a habit of stuttering is unconsciously cultivated as a mode of self-defence. The backward child in particular is prone to preserve his stammer as a screen behind which his lack of understanding may be hidden. While struggling over his opening words, he is surreptitiously gaining time; he can observe the effect of his half-answer, and change the gist of it when he sees he has started on a faulty tack. The listener, he finds, will frequently take for granted all that he seems about to say; and so his trick of spluttering over the first few syllables of a non-committal commencement saves him from the exertion of thinking out a finished reply, and the risk of being wholly wrong. In class, when fluency is required, the teacher may pass him over altogether; and thus he dodges a good deal of work that is too hard for him. Where social embarrassment tends to induce a stammer, its effects will partly shield the youth from further social contact; for no one cares to keep company for long with a stammerer. In this way the very symptoms of nervousness offer a protection to the nervous. And accordingly, for reasons such as these, many stammerers secretly possess a strong incentive, not to overcome, but to cling to their impediment.

In the severer cases the underlying causes are more deeply hidden, and may even go back to the earliest experiences of the child's emotional life. Nothing short of a psycho-analytic study of the child's whole emotional attitude may then suffice to reveal the true nature of the trouble. In a few the stutter will be found to rest on a typical compulsion-neurosis: these, it should be noted, are the cases in which the neurotic character of the child is most easily missed. In the vast majority it proves to be a form or manifestation of an anxiety-neurosis: in such cases its secret or unconscious purpose is commonly to prevent painful memories, repressed currents of thought, views and ideas about which the stutterer feels ashamed, from unwittingly betraying themselves in speech. The isolated stammer of

[1] *As You Like It*, III, ii, 211.

the guilty child, suddenly cross-questioned about his wrongful actions, is a typical illustration of the process ; and a full case-history may sometimes show how the chronic stutterer has taken up this attitude and allowed it to become habitual. The thoughts that originally provoked, and perhaps are still responsible for, this tendency towards habitual repression may be of various kinds. In some cases they may consist in vague feelings of fear or hostility towards some particular type of person with whom the child has frequently been forced to talk—a parent, for example, or a teacher, or, it may be, any stranger or person in authority. In other cases the ideas or memories may relate to sexual experiences, or to recently acquired sex knowledge. More often there is a general sense of failure in the face of all social situations ; and the so-called 'complex' underlying the neurosis is an 'inferiority complex' rather than a 'sexual' or 'parental' complex.[1] The child is backward in class, hopeless at games, has never been popular with his playmates, and so has come to feel that whatever he does or says will be wrong. Here possibly a sense of humiliation rather than anxiety or fear is the generating emotion.

(4) *Cognitive Factors.*—Of the numerous writers who have

[1] What may be termed the Freudian interpretation of stuttering, with an emphasis on the sexual character of the stutterer's complexes, is stressed and even over-stressed by I. H. Coriat ('Stuttering as a Psychoneurosis,' *Journ. Abn. Psych.*, IX, 1914, pp. 417 *et seq.*—one of the earliest and most important contributions to this aspect of the subject). What may be termed the Adlerian interpretation, with the chief emphasis on social failure, is put forward by J. F. Fletcher (*The Problem of Stuttering*, 1928). It is interesting to note that in his earlier work Fletcher himself argued that the nervousness 'should be regarded as an effect rather than a cause' (*Am. Journ. Psych.*, *loc. cit. sup.*, p. 201) ; in his more recent volume he protests against the 'diagnosis of stuttering as a mere physiological inco-ordination' and against the common treatment by means of respiratory exercises and phonetic drill based on such a diagnosis.

Generally speaking, those writers who attempt a psycho-analytic interpretation of stuttering are a little too prone to limit their exposition to some single type of causation ; they apply their favourite principle of 'over-determination' to much too narrow a field. Not only does each writer, as a rule, recognize only one type of unconscious motive ; he also passes over almost entirely the non-emotional factors.

discussed the psychological nature of stuttering, few have realized that intellectual processes, as well as emotional processes and motor or muscular, may be disorganized or deranged. Yet this is the point on which stutterers themselves often lay greatest stress. At times they even speak of their disability as constituting, or as resulting from, a sort of intellectual defect. 'I feel such a fool,' says one student, 'whenever I have to talk or answer a question promptly. My mind becomes a blank in the middle of a sentence; and then I stutter because I've no notion of what I was going to say.' 'When I stutter,' says another, unintentionally illustrating his point, 'I seem to lose the th—th—thingumabob—I mean the thread of what I am saying; I have to stop to remember what I'm talking about.' And he adds, in answer to a further question: 'I am not sure whether I stutter because I stop, or whether I stop because I stutter.'

A kind of verbal amnesia is thus an incidental feature frequently elicited during the study of stutterers old enough and intelligent enough to describe their inner mental processes. No doubt, like other forms of functional amnesia, it is the outcome of psycho-neurotic inhibitions; and the stutterer's emphasis on his intellectual confusion is not to be accepted as a final account of his trouble. But the psychologist, while admitting the profounder influence of the unconscious factors, cannot neglect the more conscious. The intellectual lapses, that seem so prominent to the stutterer himself, are bound to aggravate the tendency to stutter, even if they are not its sole or original cause. The inner impediment in thinking results in an outward impediment in speech.

At times, however, particularly with the dull and backward, I am inclined to believe that some constitutional weakness in this direction may be the prime determining factor causing the emotional disorder to take the special form of a speech-defect, instead of some other manifestation—asthma, palpitation, tachycardia, 'nervous dyspepsia,' or the like. Thinking, for most people, when clear and explicit, consists in speech that is inwardly imagined —in a series of verbal images, as they are called. Such

images, as we shall learn in a later chapter,[1] may take either an auditory or a motor form ; more frequently perhaps both forms are more or less fused and combined ; occasionally, though far more rarely, there may be visualized memories of words or phrases as seen, as it were, in writing or in print. Now, on making an intensive, all-round study of the mental processes of certain stutterers, I have noted that a number of them seem in some way defective in regard to their verbal imagery. This may at times be inferred from the results of special tests (though in themselves such tests are not very trustworthy) ; and it is continually borne out by the introspections of the older and abler patients. As already mentioned, a similar peculiarity is also found in certain types of lalling. I fancy, however, that, in those whose pronunciation is defective or indistinct, the verbal imagery is marked more by a lack of clarity,[2] whereas in those who hesitate and stammer it seems marked chiefly by a lack of promptitude and spontaneity. Many at first deny that they possess any verbal imagery at all. Others declare that their memory-images for words and phrases can be summoned up only with great difficulty and after an undue delay—an avowal which can in some measure be checked by a formal test with a stop-watch.

In this respect, the commonest and most significant feature is the wide discrepancy between the slow arrival of their silent verbal imagery and the fast rate at which they tend to speak. Many rattle on so rapidly that their utterance quickly outruns both the imagery and the general kinæsthetic control that should guide what they are trying to say. The thought of the next word in the sentence seems to get left behind ; perhaps its first letter only comes to the tongue. The speaker then bridges the pause by reiterating this initial sound until he has recovered his memory of the complete word. In the end the trick becomes as mechanical as the orator's unconsciously repeated 'er's' ; and a stammer develops on this basis.

[1] See below, pp. 517–9.

[2] This statement is based on work with students showing obstinate mispronunciations in foreign languages (usually French) rather than with children who lisp and lall ; the latter are commonly too young to give very reliable reports about their mental imagery.

Among the stuttering children I have studied, at least 32 per cent. appeared deficient in readiness or clearness of verbal imagery. At the same time, however, other conditions were nearly always observed which had doubtless contributed towards the stutter; and in several cases it seemed highly likely that the ill-developed imagery was as much a result as a cause. In the dull, as I shall show later on, verbal imagery is apt to be weak or wanting; hence it is not surprising to find that among the duller pupils an association between stuttering and deficient verbal imagery is at once frequent and close. I have encountered no case of a typical, fully developed stutter which could be attributed solely to this weakness. But, in at least half a dozen instances, I have found the difficulty over inner speech one of the easiest and most effective points to attack.[1]

(5) *School Conditions.*—In the classroom the most important factors are the teacher's attitude towards the child and the child's attitude towards his teacher, his schoolfellows, and the subject of his lessons. These points I have already touched upon in discussing the emotional causes. But there are in addition various minor influences that favour stammering in particular cases. In a few instances, the hesitation seems to spring from an excessive preoccupation with consonants, induced or aggravated by ill-advised phonic drill; such drill at times engenders a sort of bewildering mouth-consciousness, and so, like all attention to functions

[1] Two writers appear to have noted that stuttering at times rests on a kind of amnesia. C. S. Blumel (*Mental Aspects of Stammering*, 1932) declares, rather sweepingly, that all stammering is 'an impediment of thought and not primarily a speech defect. . . . The speech imagery recoils from the stutterer's mind for the moment.' He refers almost exclusively to auditory imagery. In my experience it is more often the kinæsthetic imagery than the auditory that is faulty, if only because, with most persons, the guidance and control of speech is kinæsthetic rather than auditory. W. B. Swift, on the other hand (*Speech Defects in School Children*, 1918), attributes the disability to a visual amnesia. This I find to be comparatively rare. I have noticed it occasionally among training college students who have spent most of their previous years over books and papers, and then, when they require to express themselves not in writing but orally, develop a hesitating speech that at times amounts to a definite stammer. It is often noticeable when a student starts trying to speak in a foreign language that he hitherto mainly got up from books.

ordinarily automatic, throws the component processes temporarily out of gear.[1] In others the impediment may develop out of the falterings and verbal conflicts that arise from a double vocabulary—as in bilingual children, or from a double mode of speaking—as in cockney children whose native accent or vocabulary has been constantly corrected in school. Sometimes rapid-fire questioning round the class may foster an over-eager haste, and this leads on to cluttering and stuttering. Frequently the stammer is said to be copied from another pupil in the school. A head-mistress tells me the story of an assistant teacher who had a class of fifty girls; she admitted one stutterer at the beginning of the term; and before the end of the term she had nine. My own impression is, however, that when these incidental conditions have provoked a definite stammer there has always been a prior predisposition in the child himself. In a class for speech-defectives, stammerers and non-stammerers can be safely taught together; rarely, if ever, do the latter pick up fresh tricks from the former.

III. Treatment of Speech Defects

General Educational Problems.—In turning to the practical treatment of these various troubles, whether lisping, lalling, stammering, or stuttering, the first point to realize is this: in the vast majority of cases the main task will primarily devolve on the teacher, not, as is so often assumed, on the surgeon or the doctor. As we have seen, actual malformation of the speech-organs accounts for no more than a very small proportion of the defects. As a rule, they are due, not to tongues and mouths that are badly constructed, but to tongues and mouths that are wrongly moved; directly or indirectly, these faulty movements are the outcome of wrong methods of speaking learnt during earlier years, and the ultimate cure will consist in re-learning better methods under intelligent guidance. Any physical deformity, any weakness of health, any deep-seated nervous disorder, should, if possible, receive proper medical attention; but the correction of the speech-habit in itself is not a medical but an educational task.

[1] On this point see Huey, *Psychology and Pedagogy of Reading*, p. 598.

Under existing conditions, it will be well to refer the rarer and more serious cases to a speech-centre for a full examination and, if necessary, for a special course of training. The ordinary teacher cannot hope to deal with them unaided; and in the classroom they are bound to constitute a peculiarly harassing problem. Just as the speech-defective may himself have picked up his bad habit from others, so others in their turn may unconsciously imitate him. In the higher classes his indistinct or dilatory replies hold up the course of the regular work, distract the attention of other pupils, and even provoke ill-repressed mockery and amusement. Moreover, until the child himself has taken the first steps on the road to self-improvement, the rapid oral work of the ordinary class is bound to intensify his special difficulties. To speak in front of one's fellows, if one's speech is deficient, is an added strain; and the presence of hypercritical classmates renders the child's discomfort worse. Thus school becomes for him a place of mental tension and torture, not a place where he expects to be comforted and cured.

Experience shows that, with three or four hours' systematic training every week at a speech-centre, nearly half the stammerers and most of the lallers lose their defects in the course of five or six months.[1] With dull and backward cases, however, the special speech-centre is far less successful. Moreover, the policy of treating speech-defectives—particularly stutterers—in special classes or groups is by no means an ideal psychological procedure. Could the attitude of teachers and of fellow-pupils be changed, and teachers themselves instructed in the best methods of treatment, there would be much to be said for leaving the milder cases to be dealt with at the child's own school.

[1] In London there are under the Council several central classes or clinics for speech defectives. Of the children who pass through them year by year, about two-thirds are boys. The vast majority are stammerers; and from 40 to 50 per cent. are discharged as 'cured' or 'provisionally cured.' Those who are discharged are followed up for at least three consecutive terms; and about 10 to 15 per cent. are found to relapse. These are readmitted for a further course; and the majority are again 'cured' or 'provisionally cured' within the space of a year or less.

To deal with a backward speech-defective, it is not sufficient to know how to treat speech-defects: the instructor must also know the backward child, and understand how to modify the ordinary technique to suit his dull mentality. As we have seen, one backward child in seven suffers from defective speech; and of all remediable defects this is probably the one that hinders educational progress most. I propose, therefore, to report at length the detailed methods I have tried and tested (with the collaboration of teachers in several ordinary and special schools) and have found most effective in dealing with the numerous cases of this kind.

Speech I have described as a tripartite mental activity including cognitive and emotional as well as motor or neuro-muscular processes. It follows that, in theory at any rate, the re-education of the speech-defective must include three corresponding lines of approach. To improve the child's whole emotional attitude towards speech and towards the social situations in which speech is required, to increase his intellectual control over self-expression through speech, and at the same time to correct the motor or neuro-muscular processes involved—these are the immediate aims to be pursued. Which of the three is the most important in any particular instance, and how it is to be carried out in detail, can be determined only by an all-round study—social, psychological, psychiatrical, and phonetic—of the individual child. Hence, to understand and deal successfully with the severer cases, the experience and the efforts, not of one specialist, but of several, may be required.

Treatment of Lalling and Lisping.—In treating a simple case of lalling or lisping the first step will be to determine which of the several causes I have enumerated above are responsible for the actual mispronunciations noted. For this purpose a preliminary examination by a specialist will generally be desirable, if only to exclude the possibility of physical or mechanical defects. If we may assume that anatomical deformity, defective hearing, gross nervous disorder, and the like, have either been ruled out, or else have been rectified (so far as rectification is possible) by the surgeon or psychiatrist, then the primary task of the teacher will be

to correct the faulty motor habits which the child has acquired. At the same time, he must not neglect the intellectual and emotional factors. If, for example, the child is dull or backward, he must not be expected in his daily work to read or reply with hard words well beyond his comprehension. If his babyish style of speech is partly maintained as a deprecatory way of apologizing for his ignorance, then he must not be constantly plied with difficult questions or problems that tend to keep this attitude alive.

Anyone who attempts to correct defects of articulation requires at least two things. First, he must have an ear sufficiently trained in phonetic discrimination to recognize what is wrong with the child's sounds. Secondly, he should know enough about the formation of speech-sounds, English and un-English alike, to understand how the right sound is made, and to guess what the child is doing when he makes the wrong one. Too often the teacher vaguely realizes that the child's utterance is at fault; but he is not able, or does not trouble, to analyse more precisely where the error lies. A good test is this: can the teacher produce the wrong sound himself? Unless he can, he is not likely to succeed in putting it right.

Most teachers place their trust in one simple principle—that of imitation. All they have to do, they fancy, is to say the word or the phrase over to the child clearly, smoothly, and correctly; and the child, in virtue of some occult mimetic faculty, should be able to repeat it forthwith. This naïve approach is hardly ever sufficient. A little reflection will show that what the child must aim to reproduce is not the sound as such, but the movements necessary to make the sound, without at the same time making any interfering movement. Take care of the movements, and the sound may take care of itself. But unless the teacher watches the movements of the child, and unless the child tries to copy not the sounds but the movements of the teacher, both are likely to fail. Would any musician go up to the organ, play a complicated chord, and then turn to his pupil, without more ado, and say: 'Now make the same noise'? Rather, he would show him the keyboard, and

tell him what notes to strike; point to the stops, and tell him which to pull out; indicate the pedals underneath, and explain how to press them down; nor would he forget to make sure that the blower was pumping wind into the instrument at the proper moment.

Correcting faulty vowels and consonants in English is not unlike correcting a faulty accent in French; and the principles newly introduced for teaching a foreign pronunciation may often be helpful in teaching native sounds. Until lately the same faith in simple imitation governed oral work in modern languages. The result any psychologist could have easily foretold. The teacher utters a French vowel; the child produces the nearest equivalent from his habitual repertory; and the ear of the child (and too often, alas, the ear of the teacher) is insufficiently trained to detect any difference. The recent introduction of phonetic methods is revolutionizing the English student's pronunciation of French. The same scientific approach must be adopted to improve the speech-defective's pronunciation of English.

Should the teacher feel any doubt about the value of this advice, then, before expecting the child to mimic the right sound, let him try himself to copy the sounds of the speech-defective, with and without an explanation of how it is done. Let him try, for example, to make the unvoiced Welsh *l* that so many little lispers substitute for *s* or the semi-French nasalized vowels that so many little cockneys introduce into their phrases. He will find that, until he discovers what to do with his own lips and tongue, he will produce a very poor parody. But, once he understands how to place his speech-organs, only a slight re-adjustment under the guidance of the ear is requisite to achieve a perfect echo.

The child has the same difficulty. Since his trouble often springs from poor auditory discrimination, his own hearing may be the last thing to be relied upon. For him, to distinguish between the right and the wrong movements is far more important than to distinguish between the right and the wrong sounds. Once the teacher has found out what wrong movements the child is making, then—provided, of course, that he himself knows what are the right movements for

the child to substitute—the various devices to be adopted to aid him will depend mainly upon common sense and ingenuity, and upon a general experience of how to get young people to do exactly what is wanted.

With most cases of lalling and lisping the actual procedure may profitably follow that employed for those who cannot hear at all—the deaf-mute. The teacher first demonstrates the requisite position of the lips, teeth, and tongue, exaggerating it a little where it differs from the child's; and the child is then gradually assisted to place his own vocal organs in the position shown. To help the child to control his own speech-movements, he may be taught to 'feel' them,[1] or to watch them in a mirror, instead of merely listening to the sounds they cause. He may, for example, be shown in a looking-glass how, when he says 'pibe' for 'five,' he is putting his lower lip against the upper instead of against the teeth, and how, if he will only place his tongue visibly between his teeth, he can easily say 'the' and 'think' instead of 've' and 'fink': if he still produces labials, his lower lip may be gently held away from his upper teeth with a spatula or spoon. Again and again it may be discovered that the child already possesses the sound that is wanted, but uses it only in

[1] I do not mean that he should simply feel them by the sense of contact, as with the finger exploring the mouth, or the tongue noting where it touches the teeth or the palate: that is sometimes a help. I mean rather that he should feel the movements and positions by the muscle-sense that is inherent in the moving organ. When the tongue is curled back without touching the palate or teeth, when the uvula vibrates rapidly to make a continental *r*, or when the soft palate is lowered to produce nasal sounds, we can dimly sense the muscular contractions. Let the child whose soft palate is weak repeat such a word as 'kitt'n'; as the soft palate suddenly opens to allow the *t* to explode through the nose, he will usually experience a distinct little movement far back in the roof of the mouth. As we have seen in studying the control of the hand in writing, individuals differ considerably in the degree to which they are conscious of such muscular sensations. But the notion (shared apparently by many phoneticians who are ignorant of the existence of this sixth or muscular sense) that we only know the position of our movable members when we actually see them is demonstrably absurd. When we wake up in the morning, are we unaware of the position of our arms and legs until we have looked down at them in bed or seen them reflected in the wardrobe mirror?

certain words or in certain positions. 'Ring' he may pronounce with an adequate *r*, yet 'bwing' he may say with a labial semi-vowel because of the preceding labial *b*. In 'breathe' he may manage the final *th*, because it is voiced and final; but 'three,' with its unvoiced initial *th*, he converts into a babyish 'free.' For the medial *t* in 'letter' he may always substitute a glottal stop ('leʔer'), although the initial *t* in 'ten' he invariably renders correctly.

The science of phonetics is too complex and advanced to be taught systematically to the average school child. But, with older or brighter pupils, a simple talk on elementary principles from a scientific standpoint will not only help the child to understand how his mistakes may be corrected; it will also assist him to assume an impersonal attitude towards them; he will realize that it is not so much some embarrassing oddity of his own that he has to think of, but rather the mechanics of sound-production as illustrated in his own case. With the younger and more backward pupils abstract explanations will seldom be of much avail. To secure the proper lip and tongue positions expedients more concrete and practical must be tried—games at making strange noises and pulling strange faces, imitating animal cries, and the like. The tongue-guide will be a constant help. And, generally speaking, with the very dull the methods should approach those already in common use in special schools for improving the speech of the mentally defective.[1]

In these various ways, by attacking the difficulties along scientific lines, the teacher may be able to elicit in two or three minutes a sound which has baffled the child for three or four years. That, however, is but the first step in his training. Certainly, it is no small triumph to prove that the child can, after all, pronounce a word correctly which hitherto he has persistently mispronounced. But the next stage will be longer and more tedious, though absolutely indispensable. The child has now to unlearn the old bad habit and cultivate a new and better one. He has to fix and fortify the right pronunciation which he has at last managed to accomplish. To this end the teacher must contrive a set of graded exercises which will lead the child

[1] For details see the L.C.C. *Report of a Conference on Speech Training* (1916).

to make the new movements again and again with ever-increasing ease, and eventually to incorporate them, automatically and with no thought or effort, into his ordinary conversation.[1]

Here it will be helpful to enlist the active co-operation of some member of the family; for the practice must be continued at home. The object will be, not merely to reinforce the exercises carried out at school, but to prevent the wrong habits being revived so soon as the child is out of the classroom. Further, I would suggest that the work of those who have to deal with senior children would be enormously lightened if the trouble was attacked from the earliest possible stage. Teachers in infants' schools should endeavour to banish lisping and baby-talk directly the youngster comes under their care. With the normal this is ordinarily done; with the dull, who demand extra time and attention, the task too often is shelved, in the fond hope that the child may spontaneously grow out of it. And, during these earlier years, the collaboration of the parents will be doubly necessary and doubly effective.

At the intermediate stages, however, when the bad habit is already well fixed, it may at times prove wiser to postpone any attempt to overcome it until the child is older still; while he is young, the dullard's powers of attention, auditory discrimination, and motor control may be too feeble for him to participate successfully in the labour of self-correction. The child who lalls and lisps so much as to be almost idioglossic should be separated from all who understand his jargon: with these more extreme cases, special oral gymnastics for exercising the tongue, the lips, and the muscles of speech generally, will often be helpful; but, as a rule, such children need prolonged and systematic treatment from an expert.

[1] Useful suggestions will be found in Miss I. C. Ward's two little books: *Defects of Speech: their Nature and Cure* (Dent, 1923) and *The Phonetics of English* (Heffer, 1929). The latter treats the theory of the subject from a practical point of view, and is specially addressed to the teacher who has to deal with indistinct or dialectal speech. Cf. also Scripture and Jackson, *A Manual of Exercises for the Correction of Speech Disorders* (F. A. Davis, 1919).

Nasalized speech seems to cause the conscientious teacher more anxiety than any other form of mispronunciation: we have, indeed, already noted how prevalent it is among backward children from the city slums. Its treatment, therefore, requires discussion in somewhat greater detail. The first essential is to ascertain the probable cause. As noted above, a nasal quality is given to speech-sounds either by an open nose, as in cases of cleft palate, or by a closed nose, as in cases of catarrhal obstruction. But, further, the opening or closing of the nose may be due not only to structural changes, but also to failure to lift or lower the palate, both nose and palate being in themselves perfectly normal. Where the palate is congenitally malformed, many sounds may remain impossible until an operation has been performed.[1] In such cases the cleft can often be closed with a fair measure of success. If, however, the operation is not undertaken until the child has already started to speak, further training will be necessary to teach him the new and correct sounds, and to help him unlearn the old and incorrect. Where there is no malformation—the commoner and milder case—the main point will be to practise the child in the control of the soft palate. Here the most difficult step is to persuade him to direct his breath through the lips instead of through the nostrils. Innumerable exercises may be invented: blowing, whistling, yawning, holding the breath, and the like. The tiniest child will be delighted when for the first time in his life he succeeds in puffing out a candle. The next manœuvre will be to get him to blow out a row of candles (imaginary candles will do) by taking a long breath and then emitting the air in a series of short sharp whiffs; this may be done first with the nose pinched and then with the nose free except so far as the child closes it from within by means of his soft palate. The older child may be taught to breathe on a mirror through his mouth instead of through his nose, the two possible currents of air being kept separated by a horizontal card held underneath the nostrils, so that he can see what

[1] For the surgical aspect of these cases the reader may refer to Arbuthnot Lane, *Cleft Palate and Hare Lip* (Adlard & Son, 1916). See, however, footnote 1 above, p. 392.

happens ; or two feathers may be placed on two cards, one below the nostrils and the other below the lips, and he may then be told to whistle the lower away without stirring the upper. The intelligent child can be instructed to open his mouth in a yawn and watch in a hand-mirror for the movement of his palate as he utters a nasalized and a non-nasalized 'ah'; gradually he will come to associate the proper action with a peculiar feeling at the back of his mouth, and this will serve as a temporary guide.

Once the child can close his nose from behind, and force the air-stream through his mouth alone, it will be quite simple to teach him the labials *p* and *b*, since the necessary lip movement can be watched in a mirror ; each sound should be uttered several times in succession—' p', p', p' '—as a series of puffs. The union of consonants may be practised on the same principle ; the child may be taught to hum a continuous *l* sound, and meanwhile to keep bringing the lips together without any interruption of the voice, thus producing the combination 'bl...l...bl...l...bl...l...'. Later he can proceed from the stops made with the lips to the stops made inside the mouth—the dentals and the gutturals. For the back consonants, like *k* and *g*, whose formation is difficult to watch, the child may start with such words as 'think' and 'finger,' when it will often be found that he can really make a slight plosion provided it follows a corresponding nasal consonant. To get rid of the glottal stop, so constantly substituted for *p*, *t*, *k*, and the like, the best method is to sing an open vowel, such as 'ah,' and then loosely close the lips for an instant, the child concentrating all the time on the continuous singing of the vowel ; the result will be 'ahpahpah'; when this is successfully managed, proceed in turn to 'ahtahtah,' 'bahtah,' and so to 'butter.' The sibilants are the hardest consonants of all, and should be left till last ; provided, however, the child has now learnt to control his soft palate, the only trouble will be to get the organs into proper position. This can be done with a tongue-guide. For further practice, let him keep sounding the letter *z* continuously, buzzing up and down the scale like a blue-bottle on a window-pane ; then whisper the buzz, and so produce the unvoiced *s*. To denasalize

vowels, isolated vowel-sounds should be practised, beginning with the close vowels *ee* and *oo*, and then passing to juxtaposed sounds like 'zeezee...', 'zoozoo...', and 'ee-ay-ee-ay,' 'oo-oh-oo-oh.' Singing the more open vowels, first softly, then louder and louder, both smoothly up the scale and in leaps from a low note to an octave higher, will strengthen the palatal muscles still further.

For the rest, with this as with all other remediable defects, the training should throughout proceed by positive rather than negative methods. Show the child how to produce the right sound; do not scold him for producing the wrong one. So far as possible, keep his consciousness away from his defects, instead of turning it on to them by direct expostulation; and, above all, take no notice of his peculiarities in front of others.

Treatment of Stammering.—Stammering, we have seen, is due to a number of different causes, several being discoverable on closer study in nearly every case. Those who have written on the subject in the past, and deduced measures of treatment from their views, have generally laid chief emphasis on a single type of causation only, and have thus become enthusiasts for some one sovereign remedy, with a strong disposition to belittle and decry all other modes of approach. The practical psychologist, however, forced to handle a wide variety of cases, soon finds it essential to adjust both his theories and his methods to each individual child. An eclectic point of view, exploring, and so far as possible redressing, all sides of the stutterer's problem, will prove in the long run much the most effective.

1. *Physical Hygiene.*—The simpler, physical factors are most easily detected, and may therefore be dealt with at the start. As with all nervous disorders, the success of the mental treatment will depend largely on the state of the child's general health. If he appears weak, anæmic, poorly nourished, or unnerved from recent illness, then a preliminary stay in the country, or at an open-air residential school, will greatly assist the subsequent measures. Any malformation that renders particular sounds difficult to pronounce should, if possible, be corrected first of all. At the same time, it must be remembered that the shock of a minor operation—the extraction of teeth or the removal

of adenoids—may heighten rather than diminish the child's nervous instability.

Even when the whole course of training is over, it will still be wise to see that the child is kept as physically fit as possible. The healthy child more readily withstands the little emotional strains of daily life at school; and the occurrence of some trifling indisposition, such as a cold or a sore throat, is very apt to be followed by a fresh outbreak of stuttering. In case after case I have seen many weeks of therapeutic effort stultified by a neglect of these obvious precautions.

2. *Psychological Training.*—The threefold method of approach which I have advocated for all serious forms of speech-defect will be found more especially advisable in the treatment of the stutterer: with stuttering, even more than with lalling, it is essential to consider, not merely the particular motor habit which the child has contracted, but also the emotional or intellectual factors that have helped to cause it and may still be keeping it active.

(i) *Emotional Factors.*—In most instances, as we have seen, stuttering is to be regarded as an incidental outcome of a wider and a deeper emotional disorder. The ideal method of treatment, therefore, will be to attack, not the symptom but the source. An expert investigation should be undertaken into the child's mental condition as a whole; and the detailed measures to be adopted will depend largely on the nature and the severity of the underlying neurosis. The general methods of treating neuroses in the young I have discussed more fully elsewhere.[1]

Even where the nervous symptoms are not themselves conspicuous, much success may be achieved if the case is treated, not perhaps by formal psycho-analysis, but along psycho-analytic lines. Any disagreeable experiences or fears that have precipitated the habit may be gently elicited and discussed in private; doubts and hesitations must so far as possible be removed; and generally, before we can correct the child's stammering, we must endeavour to correct his character.

Nevertheless, this general approach will of itself rarely be

[1] See *The Subnormal Mind*, pp. 161 *et seq.*, and pp. 549 *et seq.* below.

enough. To allay the sufferer's qualms, or to relieve his emotional tension by working down to the underlying complex, may suffice to remove the original causes; but it will not necessarily abolish the more lasting effects. Even when a temporary cure has been accomplished by such means, the patient is very liable to relapse so soon as he passes away from the personal influence of the psychiatrist. The psychiatrist, therefore, must combine his efforts at analysis or psycho-analysis with some form of re-education. He must endeavour to rectify the patient's whole emotional and intellectual attitude towards the problem of speech and towards those social situations in which speech is inevitable.

Stutterers, particularly those of the hysterical type, are often highly suggestible; and suggestion may play an important part in the cure, just as it has done in the production, of the disorder. Hypnosis at times yields surprisingly good results; but, as a rule, indirect methods are at once more practicable and more effective.

In this part of the process the teacher's co-operation will be invaluable. How many children stutter because they expect to stutter, and because those around them, teacher and fellow pupils alike, are always expecting them to stutter! More by his method of handling the child than by any explicit statement, the teacher can help to convince him that there is no real reason for him to become nervous or confused before others; and, little by little, he can be brought to realize that, as a rule, he only stammers in his speech when he is flustered in his mind.

Above all, destroy fears about the defect itself. Build up by every possible means an assurance that the child can overcome it. The remarkable success achieved by trainers with novel and specific devices springs less from the excellence of the devices themselves (which are often in direct opposition to one another) than from the inventor's personal faith in them. The conviction of the teacher inspires confidence in the pupil; and a confident belief that there is no need to stammer is a key to half the recoveries.

(ii) *Intellectual Factors.*—With the dull and backward it will be particularly important to take into account the intellectual difficulties that hamper fluent speech. Stutter-

ing, as we have seen, largely arises because the stutterer's attention is divided; instead of leaving the mechanical process of speaking to take care of itself, he over-concentrates on processes of articulation, and so is unable to continue thinking while he speaks. Now any learning process that demands a well-regulated attention is apt to be ill performed by the dull or the very young. In practice, therefore, it is helpful to persuade the stutterer to fix his thoughts on what he is uttering rather than on the actual process of utterance. The less intelligent, and those whose minds are easily perplexed, may be instructed to attack the two processes—the intellectual and the motor—in succession, instead of simultaneously; let the child first of all think out clearly to himself whatever he proposes to say, and only after he has conned his little formula by heart let him venture to utter it aloud. We are all familiar with the public speaker whose phrases come so slowly to his lips that he has to fill up the gaps with a hesitating 'er...er...er'; the advice regularly given by the elocutionist is that the stumbling orator should get up both the subject and the vocabulary of his speech before he rises to his feet, and, if necessary, memorize the opening sentences, so that the words lie ready at the surface. The same principle can be applied to those instances of stuttering where the difficulty lies quite as much in extempore thinking as in extempore utterance.

With many of these hesitating speakers, as we have seen, the immediate causes of their suspense arise from their defective verbal imagery. The power of formulating definite sentences, heard only in their mind's inner ear or uttered only in imagination, is weak or altogether wanting. Verbal imagery may undoubtedly be quickened up and rendered more distinct by deliberate practice; and the experienced teacher will have little difficulty in improvising exercises to this end. Jotting down an intended reply on paper before it is spoken aloud will often help the child to get the sentence clear in his own mind first of all. With most young people thinking is largely visual; and for stutterers who are good visualizers it is a useful plan to try calling up mental pictures of different objects or scenes, describing

their details explicitly but silently in words. Another supplementary device is to use what the Americans call 'flash cards': a pile of picture postcards is dealt out before the child's gaze, and he is required to say, not aloud but mentally, what each picture portrays.

If the stutterer's verbal imagery is already so vivid that he even hears or feels himself stuttering in thought, I endeavour to change the form of the imagery. The patient who, when trying to frame his statements in advance, still mentally hears himself stuttering is told to think rather of the movements or the feeling of the movements—*i.e.* to imagine himself articulating his words rather than listening to them. Another patient, who complains that he still feels himself stuttering even when he doesn't move his lips, is instructed to think rather of the sound of the sentences, noting the rhythm and inflection of his voice as though he were listening to some song ringing in his ear.

In classes for the dull and backward I have seen several cases of mild stuttering apparently cured, not by direct speech training, but by practice in oral composition. The notion that oral composition is so much easier than written composition that it can safely be neglected is one of the commonest of teachers' heresies. It is not easier, but far harder; and, if the child is backward, he needs as much practice and preparation for oral work as a normal child would require for a formal essay or a set of examination questions. One exercise, admirable for the dull and backward stammerer and applicable quite as readily at home as at school, is for the child to wander round the room with a companion or for both to look out of the window, while they gossip familiarly together, describing the things or the people they see. Here is no effort of thought, no call for an unaccustomed vocabulary, no risk of reprimand over a failure or mistake. An older child may be encouraged to try much the same thing silently by himself as he walks along the street, finding something good, bad, or humorous to say about every person he passes; nothing seems to restore the stammerer's social confidence so much as constantly fixing a critical attention on other people, and putting his comments into words.

Even in the more formal exercises of the classroom, oral composition may be silent as well as audible; and the topics may still be non-scholastic. No matter what the subject of a lesson may be, any question addressed to the stammerer should always be well within his intellectual powers, and the answer required should be very short and definite. If there is any likelihood that he will stutter, let him substitute a written for a spoken answer, other pupils doing the same, so that he is not singled out or made to feel self-conscious. During the period of training, cross-examination in class over points about which he is at all uncertain should be entirely dropped. A stammerer is readily thrown into a daze of indecision; and a passing doubt over what he is to remember, think, or choose, will inevitably disturb the firmness and fluency of his speech, and so strengthen the old habit still further.

(iii) *Motor Processes.*—In some cases these indirect methods of approach may be of themselves sufficient to reduce the amount of stammering. But the stammerer is not finally cured until his motor mechanisms are functioning fluently and easily—until speech is so automatic that neither emotional excitement nor intellectual confusion will throw it out of gear. This, as a rule, can only be achieved by a long process of habituation, and may in many cases require a more direct attack.

In this protracted process of re-training, the child's own teacher must necessarily co-operate; as a rule, indeed, he will have to play the major part. It will be desirable, therefore, to discuss this aspect of the treatment in somewhat greater detail. Here we encounter a recurrent psychological problem that has never been satisfactorily thrashed out: what form of training are we to follow—an analytic or a synthetic? Should the child first be practised in each component process separately, or should the exercises from the very outset always be exercises in speaking as such? [1]

[1] This is a problem that constantly arises in considering how skilled habits of movement are to be taught. At the moment, educational psychologists are inclined to discountenance what might be called the 'part method' and to favour the 'whole method.' In reading, writing, spelling, and in the grammar of foreign languages, they urge the teacher to start from the very outset with

Earlier methods of training favoured the analytic ; more recent methods insist on the synthetic. Both seem to base their preference rather on generalized theories than on specific investigation and research. We need urgently to undertake what the industrial psychologist would call a 'motion-study' of speech, alike in normal and in abnormal cases. My own experience indicates that each principle has its value. For the majority I recommend the synthetic ; it is at once the easier and the safer principle for the ordinary teacher. But often with the severer cases, particularly when the speech defect is associated with a dull intelligence, the slower and more cautious maxim—*divide et impera* is the only one that leads to success.

concrete exercises. The practical teacher, however, still tends to disregard this advice ; for, particularly with the dull and backward, experience has taught him that the old-fashioned method of dividing a subject into its component parts, and drilling the child until he masters each in isolation, is often more effective. In many subjects it is easy for the educational psychologist to demonstrate that this old analytic procedure was faulty ; but its defects arose mainly because it was usually based on a superficial analysis of the product instead of on a psychological analysis of the process. The traditional method of teaching writing began with straight strokes, and proceeded, *via* pothooks and hangers, to letters and finally to words. The new method begins with complete words and phrases. But such a method will have little success, especially with the duller pupils, unless there has been preliminary practice in holding the chalk and pencil, and in moving first the arm and then the fingers.

On the other hand, the industrial psychologist has clearly shown how rushing blindly at a total operation may easily lead to the acquisition of inaccurate and uneconomical habits. With certain operations and with certain individuals, it is far more fruitful to analyse the total movement into parts and stages. What may be called a 'partial part-method' is nearly always adopted by professionals who teach tennis, golf, and skating. Nor would the modern phonetician dream of reciting to a pupil complete sentences in French, and saying : 'There is the accent at which you have to aim. Now plunge ahead.'

A review of the recent literature makes it plain that the advocates of a pure or exclusively part method and the advocates of a pure or exclusively whole method were alike in error. Both principles have to be combined, and combined differently for different tasks and different temperaments. But in what proportions they are to be taken in each case is evidently a matter, not for sweeping generalization, but for detailed research. (For a lively discussion of the principles involved, see Pear, *Skill in Work and Play* ; and for a summary of laboratory investigations, see Blackburn, *The Acquisition of Skill*, I.H.R.B. Reports, No. 73, especially pp. 60 *et seq.*)

So far as its motor manifestations are concerned, stuttering, we have seen, consists in a lack of co-ordination within and between the three main mechanisms of speech—those for breathing, for vocalizing, and for articulating respectively. In any particular child, one or more of these mechanisms may be primarily at fault. In the worst cases all three function badly. With these cases I believe it to be advisable to practise each elementary mechanism alone and in turn, and then to practise them together in natural combinations. It will be safest, though not always necessary, to begin with the movements of the larger muscles first—those of respiration—and leave the control of the more delicate movements of articulation until last. With the most hardened cases of all, a long course of training, more drastic and systematic than anything the class teacher can usually arrange, may prove in the end essential. If possible, this should be separately planned for each individual by a specialist. But I may perhaps give a general outline here, from which suggestions may be drawn or adapted for the vast majority of cases.

(*a*) *Respiration.*—In stuttering, the continuous rhythm of normal speech is perpetually interrupted; and these rhythmic irregularities in speech are sometimes due to, and, when frequent, nearly always accompanied by, rhythmic irregularities in breathing. The commonest defect, particularly in boys, is a weak, unequal, jerky movement of the diaphragm, not only during speech, but in many cases even during repose. Often a slight convulsive movement can be felt by the hand, when placed over the abdomen a little below the waist, especially when the speaker stammers, or even as he starts any new phrase; a few stammerers will relate that they themselves feel some such involuntary catch, and will often attribute their stammer directly to it. Other obvious faults, which exercise will usually remedy, are shallow inspiration, broken or spasmodic expiration, expiration instead of inspiration before speaking, bad synchronization of the costal (or thoracic) and diaphragmatic (or abdominal) movements, and partial substitution of clavicular (upper rib) for thoracic (lower rib)

breathing.[1] If, then, the child has contracted bad habits of breathing, and these are sufficiently marked to interfere with speech, it will be well to begin by correcting them.

Ordinarily, breathing is automatic and unconscious. During emotion it is more or less disturbed; and during speech, especially at the earlier stages, it becomes partly voluntary. At bottom, the anomalies observable can for the most part be attributed to the interference of voluntary or emotional effort with what was originally a regular reflex process. Accordingly, I often find it an indispensable preliminary to enjoin complete silence for a week or two. This gives the reflex rhythm a chance to re-establish itself spontaneously, and allows the child to forget his faulty habits, and perhaps the still more faulty methods superimposed by some well-meaning but unscientific instructor. If necessary, daily exercises may be undertaken in correctly supplying and controlling the breath—first without, then with, phonation. These may be conveniently introduced during gymnastic work or as a preliminary to outdoor games. But, if I may judge from the experiments made in certain backward classes in London, the most effective method of achieving good rhythmic controlconsists in simple 'eurhythmic' exercises to music.[2]

[1] In the laboratory many of these faults may be clearly detected by the aid of two pneumographs, which every psychologist is taught to use (though generally for other purposes). Several German investigators have been so impressed by the frequency of these anomalies of respiration that they have revived the old claim that what fundamentally disables the stutterer is his irregular breathing (cf. Gutzmann, *Physiologie der Stimme und Sprache*, 1928, and Nadoleczny, *loc. cit. sup.*). In this country inquiries are often cited in which a large group of stammerers have been studied—in some cases under X-rays at a hospital—and 90 to 100 per cent. are reported to breathe more or less abnormally. Systematic observation has convinced me that, of non-stuttering children of the same mental type and social class, at least 63 per cent. (probably more) breathe abnormally, as judged by canons usually laid down. Consequently it is hardly warrantable to argue, as many speech-therapists have done, that because nearly all stammerers breathe badly, therefore the first step in every case is to enjoin regular exercises in breathing 'to be practised every day for about two years.' I may add that teachers of singing and elocution, like the earlier physiologists, have themselves been at variance over the correct method of breathing; hence it is not uncommon to find stutterers who have been taught two totally incompatible methods.

[2] Various formal exercises are given in most books on voice production, *e.g.*

One incidental point is noticeable in nearly every stutterer : all his muscles of speech and respiration—sometimes even the muscles of his whole body—are in a state of overtension. This doubtless is one of the chief reasons why he speaks with such explosive rapidity once he gets under weigh—as though he were burning to get it all over before the next spasm overtakes him. Since the hypertonus spreads to the laryngeal muscles, he speaks with a hard, monotonous, and often husky note. Indeed, from the very sound of the voice and from the contractions of the face and body, the experienced listener can generally tell whether his patient is about to stammer or not.

Here, then, is another factor to be abolished at the outset. Get the child to relax. Let him practise his exercises in breathing, and later in speaking, with all the unnecessary muscles in as free and easy a state as possible. Let him stand or sit as slackly as he will. In speaking, his chest should first be automatically well filled ; but all the rest of the musculature should be limp and lax. Where relaxation cannot be secured by any other means, quasi-hypnotic suggestion may often prove effective. To divert the excess of energy that threatens to cramp the diaphragm and larynx, many little sufferers hit upon the dodge of throwing all their force into some other muscle as they

W. A. Aiken, *The Voice : An Introduction to Practical Phonology* ; cf. also the references given at the end of this chapter, p. 440. With children, the types of exercise that I have found most successful are those used by Miss Fogerty and her pupils and described in her little book on *Stammering* (Allen & Unwin, 1930, pp. 41–5). It should be realized, however, that exercises which are so helpful to some patients may be worse than a hindrance to others. In several cases that I have seen, the child's efforts to change his automatic mode of breathing have simply thrown his respiratory mechanisms still further out of gear. This is why the quack, who may achieve astounding triumphs with some cases, often does others more harm than good ; the quack never adapts his methods to the individual, because he believes in one sovereign remedy for all. Except perhaps for a little general preparatory training, the exercises should be specifically selected according to the nature of the fault which characterizes the individual case. The child who takes his breath in gasps will require a different type of exercise from the child whose habit is to use up nearly all his breath before he utters a sound. Here, as elsewhere, the golden rule obtains : study the individual patient before you prescribe the treatment.

start to speak—clenching the fists, stamping one foot, or beating time with the hand. Unconsciously they are exploiting the principle of inhibition by drainage. Such tricks, though occasionally helpful at first, must not be suffered to grow into mannerisms.

(*b*) *Vocalization.*—With many stammerers, if not most, the active source of the trouble seems to spring out of the faulty control not so much of respiration as of the voice. And in regard to speech training, as distinct from improvement of breathing, the stammerer will require almost the opposite approach from that required by the child who lisps or lalls. With the latter the special difficulty, as we have seen, lies in the movements required for articulation ; with the stammerer it lies rather in the movements required for vocalizing ; nevertheless, it is on the effort of articulation that all his exertions are centred. Half unconsciously he seems to assume that sounds are formed solely with the mouth ; thus the muscles of his mouth are over-active, while his larynx and lungs appear almost to forget their function. With his lips he makes frantic struggles to ejaculate some silent consonant, like *p* in 'park,' but entirely omits the vowel that should follow ; he omits it, either because his glottis is closed or because he achieves little or no expiration, and so his vocal cords fail to vibrate. Usually his own explanation is that 'he can't say *p*.' Actually, however, he keeps on saying *p* ; and what he cannot seem to do is to let the *p* go, so as to bring out his voice on the following *ar*. The error in his explanation reveals the error in his speech: over-concentrating on the voiceless *p*, because that letter always throws him into a short panic, he tends to inhibit the more unconscious and involuntary mechanism for the production of the voice needed for the vowel. Accordingly, the child whose stammering is due to this process must, during the early stages of his practice, turn his attention rather to the voice and think less of the interpolated consonants that interrupt its flow.

With an older or more intelligent pupil all this can be easily brought home to him. He can be shown how speech requires a double control. The point can be illustrated with a bar on a cornet or a violin. With the cornet the

lips blow into the mouthpiece as the lungs blow into the larynx; the fingers modulate the notes as the mouth makes vowels and consonants: but it is easy to see that no amount of pressure on the valves can evoke a melody so long as the player forgets to blow. Similarly, with the violin, no amount of over-action with the string hand will compensate for a motionless bow hand.

With the younger and duller child the same result must be achieved by the slower and more roundabout process of graded practice. After a preliminary course of breathing exercises, vocalization may be very gradually introduced. Let him first start by singing or intoning pure vowel-sounds on whatever pitch he finds most comfortable. Then let him practise passing from one note to another without a pause, as he sounds, or rather sings, some simple vowel—*e.g.* 'ah' intoned on middle *c* rising to its fifth or octave. Owing to the cramped state of the laryngeal muscles the stutterer usually prefers to keep to a monotonous pitch. Changing the register in this way will teach him to relax the tightened vocal cords, and to get melody and flexibility into his voice when later he turns chanting into speech.

One short-cut is sometimes helpful, namely, to persuade the child to start speaking in a totally new voice, *e.g.* in a very high pitch, or, better still, in a very low one, the contrary to whatever was his custom before. He may be thus brought to build up better habits of vocalization by beginning all over afresh. Possibly, however, much of the efficacy of this and similar devices lies in diverting the stammerer's mind from his inveterate bugbear—taking his attention from the articulatory trouble by turning it for a while to the new task of using the voice in a novel way.

(*c*) *Articulation.*—The passage from simple vocalization to articulate speech must be made as gently and as indirectly as possible. Here it will be a delicate matter to decide how far it is wise to make the child think, even more frequently than he does, about the precise nature of his mistakes, and to split up the total speech process, which is already badly cut up by the stammer, still further into its component parts. Here more than anywhere else it may be a misguided policy to make the child too conscious of his

troubles. By their ill-timed comments and ceaseless exhortations, many well-meaning would-be helpers simply rivet his attention still more firmly on muscles already overactive. Speaking—and particularly that part of it which is called articulation—is one of those many functions which, once they are fully acquired, become mechanical and all but unconscious ; to think about the machinery merely results in flinging that machinery completely out of gear. For the majority, therefore, I recommend insisting from the very outset on the need for good vocalization ; and, that once grasped, the less the child thinks about his speech mechanism the better. If attention is expressly called to a speech process, it should be done chiefly for two definite ends : first, during the stage of analytic practice (if such a stage is necessary), in the exercises for easing vocalization or for learning and driving home new combinations of sound, never during ordinary conversation ; secondly, at the subsequent stage, when the formal exercises are over but fluent speech is not yet automatic, during actual conversation to remind the child from time to time to incorporate the effects of his practice into his ordinary everyday speech.

Directing the child's notice to the sounds that occasion the stammer, by requiring him to practise them in isolation, may be helpful in the long run ; but at first it may often aggravate rather than relieve the trouble, at any rate for the time being. It must be remembered that, however much attention is directed to a particular process at the outset, if *precisely the same process* is repeated again and again, and if each repetition is *successful*, then the inevitable result is for attention to that process, and even consciousness of that process, ultimately to disappear. Thus, contrary to a widespread notion, regular practice eventually tends to lessen not to intensify consciousness of the process that is repeated. With the more intelligent, I readily admit, it is wiser to aim at incidental learning and reduce attentive analysis to a minimum. But with the dull it is an inevitable consequence of their inferior mental organization that they need more explicit drill, and are relatively incapable of the synthetic or incidental type of learning.

For those who require this more prolonged course of

training the best plan will be, after correct respiration and vocalization have been rendered more or less mechanical, to start by introducing those simple articulatory movements that interfere least with the movements of breathing and phonation. Then step by step the child may proceed to those that definitely interrupt or complicate these regular, rhythmical movements, until at last he has mastered all the combinations in his language.

If these principles are followed, the first exercise will be for the child to join his lips loosely for a moment while still intoning the vowel, thus introducing the simplest voiced consonant—'ah . . . mah . . .'; then he may practise lightly raising his tongue, 'ah . . . lah.' To begin with, the voice should be kept on the same pitch: the child should still concentrate on the vowel, not on the consonant, and be careful not to interrupt the continuous tone. Next he may attempt some of the harder consonants—the voiced fricatives (*v*, *z*, voiced *th* and *zh*), and later on the voiceless (*f*, *s*, unvoiced *th* and *sh*). The voiced stops *b* and *d* should be introduced in the same way as the continuants *m* and *l*, the child being told to bring his lips lightly together for an instant, thinking all the time of singing the vowel; whispering the song will convert voiced consonants into unvoiced. The unvoiced plosives, however, should not be aspirated ('p'ha,' 't'ha,' 'k'ha,' etc.); they should be uttered rather as they are in French: a feather on a card, or a lighted candle held before his lips, will show the stammerer how he tends to puff out such sounds, instead of just gently stopping the breath stream for an instant. *W* and *y* are best taught, not as consonants, but as vowels or vowel-glides, as 'oo-ent' for 'went,' 'ee-ess' for 'yes.' With various stratagems of this sort, selected according to his individual needs, the child may be led to practise singing and intoning combinations of every consonant with every vowel ('ma, may, me, my, mo, moo,' etc.) until the syllables are perfect.

So elaborate a scheme of exercises will be attempted in its entirety only where the stammering is deep-rooted and widespread. In milder cases the teacher may venture upon a more immediate attack. Time will generally be saved if he sets out by systematically observing, on the lines sug-

gested above, where and when the difficulty mainly arises. If, as is often the case, the trouble is limited chiefly or solely to one particular stop-position, the task of training may be greatly simplified. The child's practice may be confined to these particular movements.[1] Let him practise them first in isolation; he will then find it less difficult to combine them with others; later on, he can be led, by indirect methods, to make the interpolated stop-movements more and more lightly, with diminished attention rather than increased.

Usually it will be found that the unvoiced sounds are the most tiresome of all. Here, of course, it is not the movement of articulation that is difficult in itself; the fault arises from an inability to shut off and turn on the voice at the right moment.[2] But, even when the child has acquired control over the voice by purely vocal exercises, the introduction of consonantal stops tends to inhibit the more delicate vocal control; hence the need for exercises to render the articulative movements easier. In most cases the ease to be acquired is not so much a physiological as a psychological ease; the stammerer generally imagines that for him the requisite movement of lips or tongue involves some physical obstacle; actually the particular letter or sound has become the centre of an emotional obsession. The chief value of the practice, therefore, consists in driving home the fact that he can really make this movement quite readily, so as to increase his confidence whenever he requires to make it. The purpose of the exercises is not to get the stammerer to think about the sound still more, but to banish his persistent belief that, unless he thinks about the sound, he will never be able to produce it.

As indicated above, the unvoiced consonants may best be approached through their voiced counterparts: for each pair the movement of articulation is practically the same. Brighter children will quickly appreciate the similarities and differences between the voiced and unvoiced sounds. If

[1] This economy of training cannot always be safely applied. Often the child's speech-movements are wrong throughout all his speaking, but the error only shows up clearly with certain consonants.

[2] See above, p. 397.

they can pronounce every voiced sound with little or no trouble, and stumble only over certain voiceless forms, they will often teach themselves to pass from one to the other. A teacher tells me that he successfully cured a stammering pupil by giving him the part of a country farmer in a school play, and telling him to speak it ‘ in a Zummerzet dialect ’; the boy dropped his stuttering, and later dropped the excessive vocalization.[1] Perhaps, however, the final success was largely due to the self-confidence the boy had acquired by discovering that, for the first time in his school life, he could speak in public without a stutter. I myself have known two boys who constantly stuttered over *w* (especially if it was spelt *wh*), simply because they tried to produce an unvoiced sound (as the Irish and many careful English speakers do); when they realized that, in ordinary southern English, ‘ double-u ’ is a voiced sound practically identical with *oo*, and aimed at saying ‘ oo-en ’ instead of ‘ wH-en ’ or ‘ Hw-en,’ the stutter ceased.[2] In the early stages of practice the intelligent child may find it helpful to watch the initial of each word as he reads: then, if he recognizes it as a voiced sound, he can throw his voice boldly into it; if as unvoiced, he can touch it off lightly and bring out the voice promptly on the succeeding vowel. When the stammering occurs not on a consonant but before an initial vowel (*e.g.* ‘ ʔaʔaʔ after,’ with a reiterated glottal stop), the vowel may be practised with *h* in front of it (‘ hafter ’); breathing in will often prevent the spasmodic closure of the glottis to which this form of stammer is due. With a few

[1] Strictly, the difference between the south-western dialect and the south-eastern, like the corresponding difference between north and south German, is not a difference between a consonant which is completely unvoiced and one which is fully voiced throughout: it is rather a difference of degree. The English voiced consonants, as the Frenchman so often observes, are only voiced towards the end: ‘ zoo ’ is commonly pronounced ‘ szoo ’ and ‘ bee ’ ‘ pbee.’ Hence a child who can pronounce an English *z* (as distinct from a French *z*) is already half-way towards the unvoiced *s*; he has merely to keep the voice shut off a fraction of a second longer.

[2] One of them also stuttered when the *w* came after *s* (as in ‘ sweet ’)—a common instance of stutter. Owing to assimilation, the English *w* in such a case tends to become devocalized. Getting the child to practise ‘ zweet ’ and then ‘ ss-oo-eet ’ usually overcomes the difficulty.

the glottal stop will be found a help rather than a hindrance; and in the early stages they may be taught to introduce it before the more difficult vowels, speaking rather in the north German fashion.

It will be remembered that these detailed exercises were put forward only for the severer and more exceptional cases. With the vast majority it is not the formation of the sound that causes the trouble, but the incidental introduction of it into fluent speech. Nearly every stammerer can whisper smoothly, sing fluently, shout easily, talk by himself, and join in a spoken chorus, without faltering or hesitation. This suggests five promising lines of approach. Let the child sing or whisper whatever phrases he finds irksome, then chant or intone them like a curate in church, and so proceed temporarily to a drawn-out, sing-song delivery. This semi-oratorical style will come to him more naturally if his training is carried out in a large hall, or if he is told to sing out his words from one classroom, while the teacher listens in another. Again, let him sing first to a piano accompaniment, then to a vocal accompaniment, and, little by little, let the vocal accompanist convert the duet into a semi-melodic form of speech, the stammerer following his lead. In the classroom the reading or recitation of poetry and prose in chorus is itself a useful exercise for dull and backward pupils, and may be freely exploited if a stammerer is among the number. During class-questioning, when it is the stammerer's turn to answer, he may be allowed to speak in unison with others; but this change must be tactfully manœuvred, so that he does not feel that he is being specially treated either with leniency or with contempt.

When singing is gradually converted into speech, it will be found that, with the greater number, a drawling sing-song utterance yields the smoothest form. There are, however, exceptions. A few do better if they are practised with staccato rather than legato speaking—rapping out syllable after syllable, marking time with the finger to distract attention from the speech-mechanism itself. For nearly all of them, the declamation of verse, with the rhythm well marked, proves far easier than conversational prose. In their everyday talk, instead of the jerky monotone that most

of them adopt, they should be encouraged to aim at a definite rhythm and to speak with expressiveness and modulation. Occasionally a more imitative child can be led to mimic the elocutionary efforts of a fluent speaker, particularly if he tries to pretend that he himself is the other person talking. While the recitation of verse appeals easily to the girl, the boy will join more readily in rough and tumble comedy. Give the stammerer a character part, where he can be more or less disguised, speak in an assumed or artificial voice, and let himself go in free and farcical clowning. To find his audience laughing with instead of at him will come as a stimulating relief.

Few stammerers stammer when they are alone. It is extemporary conversation in the presence of others that plunges them into a fluster. Hence provide plenty of exercises for the child to practise by himself. When others are present, let him read or recite rather than talk. If even this proves trying for him at first, begin by reading with him in private ; then gradually quieten your voice, and presently drop words and clauses here and there, so that for a short spell he has to continue alone. Later, arrange a little dialogue in which your own part consists of alternate statements and questions : the child is to repeat your statements, and to reply to your questions ; and at first the questions should be such as call for little thought and arouse no special emotion. Home practice with the gramophone, in which the child eventually teaches himself to recite short passages simultaneously with the disc, adopting the same speed, pitch, and inflections, is an extremely good method for the more intelligent and persevering. Reciting poetry and rhythmical prose to a slow-beating metronome is another exercise that they can practise for themselves ; the beats will help them to go slowly and preserve an even rhythm. To begin with, however, each will need a little preliminary supervision. At first, when he tries to reduce his pace, the child will, as a rule, simply put pauses before some of the words, still gabbling off the syllables too fast ; or he will stop to take deep breaths between the phrases. He should be told that his main need is to strengthen and lengthen the vowels—short vowels as

well as long ones. The troublesome consonants he may elide or slur over to begin with, and later just leave them to take care of themselves.

The scheme of training I have recommended is not merely analytic: it is a progressive combination of analysis with re-synthesis. Except for the severest cases, I do not for one moment recommend its adoption as a whole. It should be freely modified and curtailed to suit the individual child and the practical possibilities of the moment. One or two cautions must be added. It is not sufficient for the child to acquire the requisite co-ordinations of movements: the co-ordinations must be practised until they are not only possible, but automatic—hammered home as mechanical habits. Hence it will be extremely unwise to start on the early stages of analytic drill if there is no likelihood that the child will continue and complete the subsequent re-synthesis.

In the graded exercises I have described, however, the aim is not merely to instil good habits: it is to impart increasing self-reliance by leading the child on from tiny tasks that he can easily compass to others that come closer to the conditions of everyday life. The secret of success lies in graduating the degree of difficulty stage by stage to suit the individual child. Study the child first, therefore; else you may shake his confidence instead of raising it, by imposing a task too hard for him over which he will merely stammer as before.

With stammering, as with lisping and lalling, most of the cases that are ultimately found to need special treatment are really cases of neglect. Stammering, like good speech, is itself a habit; hence the earlier the wrong habit is taken in hand, the easier it will be to cure. Since in so many instances it starts before the age of six, the most hopeful period is during the child's attendance at the infants' department, or even during the pre-school stage when the first slight tendency displays itself. When the stammerer arrives in the senior department, energetic measures should only be applied with caution. Once the habit has become fully developed and is firmly rooted and fixed, it may often prove wiser to wait a few years, and to postpone systematic

training until the child is old enough to co-operate intelligently. In London no child is admitted to the clinics for stammerers until he is 9. With the backward, intensive training may have to be deferred till even later ; but, when the child is likely to leave at 14, it may be unwise to begin a full course after 12. With a prolonged and elaborate course of training, supplemented by proper psychotherapeutic methods, stammering, even in the more obstinate cases, should be removable in 18 to 24 months. Nevertheless, hardly any nervous symptom is so liable to reappear. Under special stress or strain—after an accident to health, or on promotion to a higher class, or again later on at puberty—relapses are almost sure to follow. Hence, even when the stammerer is apparently cured, continued encouragement and sympathy are needful, alike at school and at home, for permanent success.

(iv) *Environmental Readjustment.*—Finally, it must be remembered that no other nervous manifestation is so closely dependent upon the patient's social surroundings. At the very outset the psychologist will naturally inquire into the way the stammerer's impediment has varied and developed. He will inquire whether the stammer first showed itself at home or at school or on entering a particular class ; whether the patient stammers more with strangers than with acquaintances, in the classroom than in the playground, with his teachers or with his family, or with one teacher more than another, or with the opposite sex more than with his own ; and whether he is at any time or in any situation completely free from his infirmity. And, further, as the study of the case progresses, the therapist in charge of it should attempt to make systematic observations upon the relations between the child and the other persons with whom he comes into daily contact.

Whatever be the result of these inquiries, and no matter who undertakes the direct treatment and re-training of the child's speech, the co-operation both of his teachers and of his parents will be indispensable ; else what has been accomplished during the period of training may be continually undone in the schoolroom or the home. Teachers and parents must both be brought to understand that the child's

stuttering is due to no mere wilfulness or carelessness on his part: it is the outcome of a neurotic condition, and must be treated as such. And, if by their treatment they appear unconsciously to be keeping the child in a nervous state, explicit advice must be given.

So far as my experience goes, both the child's attitude towards the school and the school's attitude towards the child nearly always need readjusting; what special points call for rectification will emerge during the study of his emotional condition. Generally speaking, in the classroom the stammerer must be handled with the same care and consideration as any other nervous child. Corporal punishment, no matter for what reason, must be forbidden. There must be no over-pressure at lessons, no worry over subjects in which the child is backward. Whatever is likely to increase his shyness or timidity must be tactfully removed. Whatever makes for embarrassment or self-consciousness must be scrupulously shunned. Humiliation, in any field of life, is the worst possible experience for the stammerer. On the other hand, everything that may induce calmness, self-confidence, and self-command, should be unremittingly fostered; and throughout the teacher must bear in mind that, before the child can control his stammer, he must first be helped to control himself.

Tactful handling at home is equally important. Outside the school walls quite as much as within, a constant intercourse with critics, or with people who are older, more intelligent, or more efficient than he, is always bad for the stammering child. Let him associate with younger or more submissive children. Let him look after the baby, or even chatter to the cat. Nothing is so good for the stammerer as protective responsibility for somebody or something that is weaker than he. Joking, teasing, and badgering, both over the stammering itself and over other petty childish faults or foibles, must cease; discipline should be as free and lenient as possible.

At times, the attitude of the relatives is the chief factor in the situation. Those who should be the most patient and the most sympathetic are often the most intolerant and harsh. As with other obsessive habits, the parents perpetually argue

pp. 444–5). In the original series four children were noted with mental ratios under 70; these, however, were diagnosed as mentally defective, and are, therefore, excluded from my present tabulation. At Birmingham three or four borderline cases were also observed; but, owing to a slight difference in the medical standards for admission to special schools, were retained in the final lists. When a broader classification is required, children with mental ratios between 85 and 100

trast with the backward groups. For this purpose, therefore, I have fallen back on results obtained in a previous survey which covered the whole of a representative London borough. In accordance with those results, I have assumed (i) that intelligence is distributed among the general school population in approximate conformity with the normal curve (for evidence, see *Distribution and Relations of Educational Abilities*, 1917, p. 34, and *Mental and Scholastic Tests*, 1920, p. 162); and (ii) that the standard deviation is, in terms of the mental ratio, approximately 13·5 points (see *Mental and Scholastic Tests*, Table IX, p. 145: children above 11 have been excluded from the calculation, because the brightest have been transferred to central and secondary schools, and children from special schools have been included in due proportion). This figure agrees with the amount of variability found by most earlier investigators who have dealt with similar tests and populations (cf., for example, Terman, *Measurement of Intelligence*, p. 66, Fig. 2, from which the standard deviation can be calculated).

Two reservations must be made in regard to these assumptions. First, in view of the use sometimes made of these standard deviations, I should point out that a figure obtained for London by means of the Binet scale will not necessarily hold good of the entire population of the country nor of mental ratios based on more recent and more efficient tests. If the population of the country were surveyed as a whole, the standard deviation would rise much higher, probably to at least 15 points (cf. *Eug. Rev.* VI, 1914, p. 150).

Secondly, I must add that I do not consider the distribution of intelligence to follow the normal curve exactly. Elsewhere I have shown that the actual curve is a little more closely packed and peaked about the centre, while the tails—particularly the lower tail—spread out over a slightly wider range (cf. *Distribution and Relations of Educational Abilities*, p. 34; *Mental and Scholastic Tests*, p. 162). The inheritance of intelligence resembles the inheritance of stature. Distinct and abnormal characteristics, like colour blindness or night blindness, are frequently the effect of a single gene ('single-factor inheritance'). Graded and normal characteristics, such as intelligence, are the effect of a large number of genes ('multi-factor inheritance'). A few pathological types of mental deficiency are due apparently to the action of a single gene (often manifesting itself, however, only under certain environmental conditions); but the majority of persons owe their allowance of inborn intelligence, great or small, mainly to multi-factor inheritance. These forms of transmission would account for the shape of the actual curve.

will be regarded as suffering from 'slight' inferiority of intelligence only; those with a mental ratio of 85 or less I shall consider definitely 'dull'—dull, that is, in the technical interpretation of the term. Of all the cases of educational backwardness, 60 per cent. were dull in this sense; that is to say, three out of every five suffered from a marked inferiority, apparently congenital and presumably permanent, in general intellectual ability. But, as the table shows, even when the child's intelligence was not poor enough to class him as technically dull, it was still, in the vast majority of cases, below the average.

Inheritance of Lack of Intelligence.—It is now usually held that in mental deficiency the chief factor is heredity. If, then, the dullness that is so often associated with backwardness in educational attainments is itself simply a mild degree of that innate lack of general intelligence which in a severer degree is described as mental deficiency, we are naturally led on to inquire whether heredity may not also play an appreciable part in the production of the backward and the dull.

The problems of mental inheritance, however, as I have elsewhere pointed out,[1] are far more complex and difficult to disentangle than is popularly supposed. For all my cases I endeavoured to obtain family-histories that should be as complete as possible; but it is never easy to ascertain even the superficial facts: for instance, one can rarely test the intelligence of the adult members of the family. And, even when fairly precise data have been secured, our existing scientific knowledge is still insufficient for us to interpret such data with any certainty. Accordingly, the most we can hope for is some crude *prima facie* evidence for or against the natural deduction.

In Table XXII I briefly summarize, for what they are worth, the more important points elicited by inquiries into the mental characteristics of the families. For statistical purposes I have always asked those who have assisted me in these investigations to assess the intellectual, cultural, emotional, and moral characteristics of the relatives by

[1] See *The Subnormal Mind*, pp. 76 *et seq.*, for data regarding the inheritance of mental deficiency, and pp. 462–3 below for the general evidence.

TABLE XXI. DISTRIBUTION OF INTELLIGENCE AMONG THE BACKWARD GROUPS

Percentage of Backward Children with the Mental Ratios Specified

Mental Ratio.	London.			Birmingham.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.
115–120	0·5	—	0·3	—	—	—
110–115	1·0	0·5	0·8	—	—	—
105–110	0·5	1·5	1·0	—	—	—
100–105	2·6	2·0	2·3	2·1	—	1·0
95–100	3·6	5·1	4·4	6·1	4·1	5·1
90–95	10·4	8·6	9·5	10·2	14·3	12·2
85–90	20·8	22·7	21·6	30·6	22·4	26·5
80–85	31·1	33·3	32·2	22·4	33·6	28·2
75–80	19·7	18·2	18·9	15·3	18·4	16·8
70–75	9·8	8·1	9·0	10·2	6·1	8·2
65–70	—	—	—	3·1	1·1	2·0
Total . .	100·0	100·0	100·0	100·0	100·0	100·0

means of a rough rating scale, supplemented by a detailed description of the features observed. Here I have regarded a relative as subnormal if his inferiority in any of these respects is such as might be expected in the lowest 10 per cent. of the general population. If a child has among his immediate relatives at least one suffering from a disability similar to his own and such as might conceivably be inherited (dull intelligence, special disability in speech, in verbal facility, in memory, or in emotional stability), I have noted the condition as a factor that was possibly

TABLE XXII. INHERITED[1] MENTAL CONDITIONS (LONDON)

	Normal.			Backward.			Correlation with Backwardness.
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	
Intellectual (General)	18·1	21·2	19·7	52·0	58·1	55·1	·47
Intellectual (Specific)	6·2	4·0	5·1	11·4	6·1	8·7	·21
Temperamental .	7·8	11·1	9·5	17·1	23·2	20·2	·27

[1] The figures include only those cases where the child was apparently suffering from the same defect as his parents; they therefore represent the proportion of conditions inherited rather than merely inheritable.

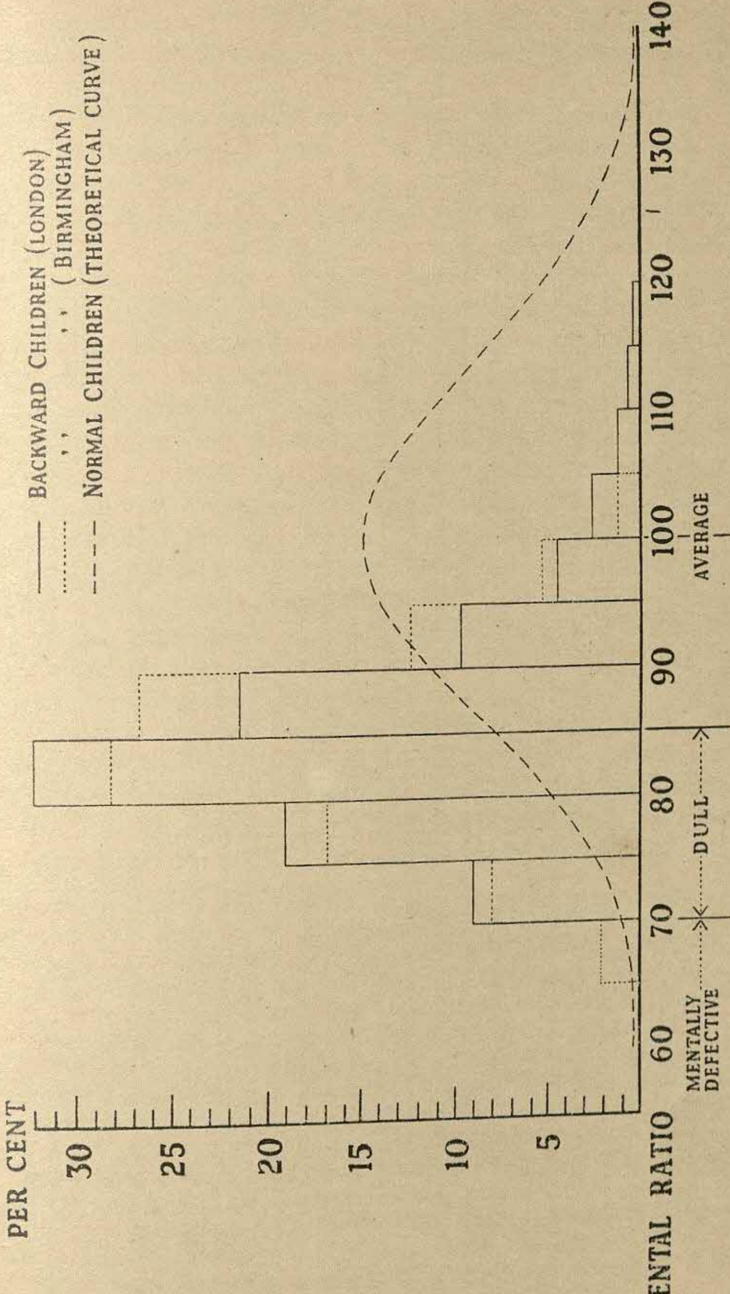


FIG. 12.—DISTRIBUTION OF INTELLIGENCE AMONG BACKWARD AND NORMAL CHILDREN.

hereditary. For the moment we shall be concerned only with the apparent inheritance of a lack of general intelligence.

In 4 per cent. of the backward cases an immediate relative—father, mother, brother, or sister—was known to be mentally defective: this occurred in only two instances (0·5 per cent.) among the control group. In 73 per cent. of the backward cases an immediate relative[1] was reported to be apparently dull in the technical sense, as compared with 21 per cent. among the normal. These percentages yield a correlation coefficient of ·64—one of the highest in the whole investigation. Such a figure, however, cannot be taken as indicating the influence of heredity, even in the loose and popular sense. In 18 per cent. out of the 73 per cent. the child himself was not dull; and if the dullness of his parents had any direct influence, it probably acted more through environmental channels—inefficient management of the home and of the child's health, general interests, and the like. Only in 55 per cent. of the cases, therefore, could it be claimed that the child's own dullness was itself presumably inherited. Even so, hereditary dullness appears an important factor. Assessed by a tetrachoric coefficient its influence amounts to ·47. Certainly, to divide the adult and the child population into the dull and the not dull is as arbitrary as to divide them into the defective and the non-defective. But correlations obtained with graded data yield much the same figure[2]: and though

[1] If remoter relatives are also counted, the figure for dullness (including deficiency) rises to 87 per cent. among the backward and 24 per cent. among the normal. But I doubt if any comparison here is trustworthy. Almost inevitably in the case of a dull child instances of dullness in remoter relatives are remembered or brought to notice more easily than in the case of a normal child. The immediate relatives were all systematically visited and personally assessed in practically every instance.

[2] In a large number of cases, within both the normal and the backward groups, I have been able to test the intelligence of the child and his parents or brothers and sisters. I find that (for 153 pairs) the correlation between parent and child is ·46, and between one brother (or sister) and another ·53 (326 pairs—the children being in all cases pupils attending council day schools). In a similar investigation carried out some years ago at Liverpool the figures obtained were ·32 and ·42 respectively (cf. Burt, 'Inheritance of Mental Characteristics,' *Eugenics Review*, 1912, IV, ii, pp. 180

the similarity between the members of the same family cannot be attributed simply to biological transmission, taken in conjunction with other facts and figures the result yields strong *prima facie* evidence for the influence of heredity.

Educational Effects of Lack of Intelligence.—Intelligence, as psychologists use the word, is almost synonymous with what the Board of Education, somewhat uneuphoniously, has called 'educable capacity.' Capacity must obviously limit content. It is impossible for a pint jug to hold more than a pint of milk; and it is equally impossible for a child's educational attainments to rise higher than his educable capacity permits. In theory, therefore, we should always expect his educational age to fall below his mental age. In practice, however, where standardized tests are applied, the former is found to exceed the latter in a few rare instances. The consequence, as we have seen in an earlier chapter,[1] is to produce an 'accomplishment ratio' of more than 100 per cent. The paradox is due to the narrower significance of the actual test-results. At times the fault lies with the tests chosen to measure the child's intelligence. They are usually of the Binet-Simon type; and if the child is deficient in power of oral expression, upon which Binet's questions so largely turn, or if for some special reason he is unfamiliar even with the slender store of knowledge that they presuppose, then his true intelligence will be underrated. In such a case, of course, the measurement furnished by the Binet-Simon scale should be checked or rectified by the application of performance tests.

et seq.). Here the lower figures may be partly due to the imperfections of the earlier form of the tests. Later investigators have obtained a correlation between parent's intelligence and child's ranging for the most part between ·3 and ·6 and averaging about ·5—a figure closely resembling that obtained by them for other mental and physical characteristics, *e.g.*, stature. Fisher has shown that a coefficient of this order is theoretically to be expected if a continuously graded character like stature is determined by a large number of genes, transmitted in accordance with Mendelian principles (*Trans. Roy. Soc. Edin.*, LII, 1918, pp. 399 *et seq.* and p. 51, above). For a summary of evidence indicating that, when adequately assessed, the 'general cognitive factor' is innate, see 'Ability and Income,' *Brit. J. Educ. Psych.*, XIII, 1943, pp. 88–92. For a physiological theory of the nature of 'general intelligence' see *The Factors of the Mind*, pp. 216–17.

[1] See above, p. 35.

Far more often, however, it is the scholastic tests that are at fault: instead of intelligence being underestimated, educational abilities are overestimated. In most instances some simple explanation lies ready to hand, and comes to light after a little additional inquiry. Sometimes the child has been sedulously coached in the more mechanical subjects, so that his achievements in the elementary exercises of the tests yield a magnified view of his true educational powers. Sometimes he profits by an exceptional memory for facts that he often does not understand, and thus is able to do himself more than justice in the routine portions of the scholastic tests. More rarely he may be gifted with a specific but limited aptitude for dealing with words or with figures, and this brings up his general average by producing unexpectedly high marks in one of the more academic subjects—in reading, spelling, composition, or even (though not so frequently, it would seem) in arithmetic; outside the schoolroom, however, he may be known for what he really is—an unpractical creature with no sound judgment and little common sense.

Among the normal children here studied there were no instances where the educational age rose appreciably above the mental age. The mental ratios were all between 95 and 105 per cent.; and the accomplishment ratios, though never low, were everywhere less than 105. This was only to be anticipated from the way the children were selected. They were picked to represent pupils with approximately average educational attainments; and such attainments they could have hardly acquired had they not possessed a capacity which was itself approximately average. The normal child is, as a rule, fairly even in his equipment and development; and, in an elementary school, there is seldom any reason why he should be individually coached or pressed on.

In the backward group there were nine cases where the child's educational age was superior to his mental age. Such cases, as I have shown elsewhere,[1] are chiefly found among those whose intelligence is somewhat below average and yet above the line drawn for the definitely dull. The achievement reflects credit on the teacher, and on his

[1] *Mental and Scholastic Tests*, p. 176.

personal interest in the individual child. But the consequences should be closely watched and judged from a broad standpoint. Out of the nine cases just mentioned there were at least three where the extra pressure had undoubtedly imposed a strain on the child's nervous health. The teacher, therefore, should consider not merely his pupils' intellectual improvement, but also the influence of his efforts on their health, happiness, and emotional condition. Poor progress is not always to be ascribed to laziness, either on the part of the child or on the part of his master. Much more frequently it is a direct and inevitable outcome of the child's inherent stupidity—a cause that no amount of industry can ever remove. Whether in any given case this explanation is the true one the teacher himself can at once discover by applying psychological tests.

In the backward groups the correlation between intelligence and educational attainments was ·78 at London and ·73 at Birmingham: in the normal groups (somewhat narrowly selected, it will be remembered, at London) it was ·63 at London and ·71 at Birmingham. In a larger unselected group at London, comprising nearly 700 boys and girls and including both normal and backward in due proportion, I found the correlation between mental ratio and educational ratio to be ·74. The correlation with intelligence was highest for composition (·63) and nearly as high for problem arithmetic (·55); for the other English subjects it was slightly lower, for reading ·54, for spelling ·52; lower still for mechanical arithmetic (·41); and much smaller for the manual subjects—handwriting (·21), handwork (·18), and drawing (·15). Thus the dull child is likely to show his backwardness most of all in composition and in arithmetical problems, and least of all in drawing and handwork. There are, however, slight differences according to age and sex: as we shall see in a moment, the younger dullards, and particularly the boys, are apt to show their backwardness more especially in reading; the older girls in arithmetic.[1]

Sheer inborn dullness, then, appears to be by far the commonest and most important reason why children fail in their

[1] Cf. *Mental and Scholastic Tests*, p. 177.

school work. It is an early arrest in the development of this central capacity that produces the feebleminded child. It is a milder form of retardation in the same capacity that produces our most genuine cases of backwardness. The capacity is an inherited capacity. Hence such cases are usually backward for life.

In at least 10 per cent. of the cases here examined no other contributory factor of any appreciable significance was detected : innate incapacity seemed the sole and sufficient cause. In most instances, however, the situation is more complex. Some extraneous cause, or group of causes—such as physical ill-health or domestic poverty, together with their attendant consequences—co-operates with some pre-existing weakness of the mind to yield a rate of progress that is in this way doubly retarded. Such a conjunction of external and internal factors was observed in more than one-half of all the backward cases tabulated above. Probably an investigation, more prolonged and penetrating, would have disclosed it in the majority.

Social Effects of Lack of Intelligence.—If mental ratios are approximately constant, and if intelligence is an inborn gift, then those who are dull as boys and girls will generally grow up into dull men and women. Further, since intelligence is indispensable for efficiency in all forms of work, we may expect that those whose dullness makes them incompetent at lessons will be equally incompetent in industry later on.

This is, however, not the view usually held by the parent ; it is not the view preached by the family doctor, or by the annual orator on speech-day who seeks to encourage the failures after handing out the prizes to the examination stars. And, indeed, the critic of current education is always ready with examples of school dunces who have succeeded in after-life, backward boys who have made brilliant men.

The Undiscovered Genius.—Beyond question there are many seeming exceptions to the rule I have laid down. Newton and Darwin, Goldsmith and Sheridan, Watt and Stephenson, Wellington and Clive—the careers of these and many another celebrity may serve to testify how a

duffer at lessons may prove a genius in disguise ; and examples of this sort are constantly quoted by well-meaning optimists who would console the parent of the backward child. 'He will grow out of his dullness as he gets older'; 'he will be all the better for not developing too fast'; 'the slow boy is usually the sure boy: he goes further in the end'; 'when he comes to the turn of life—at seven, at fourteen, at twenty-one—he will put on a spurt and make up for what he has lost': such phrases are continually echoed by comforting friends, by the family doctor who has heard of no intermediate grade between the mentally defective and the mentally normal, and even by school teachers themselves. The assumption, therefore, requires scrutinizing in some detail.

Let us note, to begin with, that arguments from isolated instances are fallacious. Systematic inquiry reveals two things: first, the exceptions that can be cited are comparatively rare ; secondly, most of the exceptions are apparent and not real.

Among all the backward cases I have examined in the elementary schools, not one had the intelligence of the weakest junior county scholar, and hardly any had the intelligence of the child who is considered just fit for a central school. Of those diagnosed while children as genuinely dull none showed the smallest sign of intellectual ability in after-school or adult life. Is there, then, any substantial evidence for the popular notion that geniuses have often been backward during boyhood and at school? With the aid of the *Dictionary of National Biography* we can make a comprehensive survey of the personal qualities and early development of most of the more illustrious figures in English history. From the data there given Havelock Ellis has sought to compile a statistical summary for the thousand most eminent persons recorded in its pages.[1] Out of the thousand, 292 are noted as having been definitely precocious in childhood, and only 44 as the reverse: of the early history of the rest we have little or no exact information, but what there is conveys no hint of

[1] Havelock Ellis, *A Study of British Genius*, p. 140. His mode of selection actually yields 975 British men and 55 British women—1,030 in all.

subnormality. Thus, after fully allowing for the limitations in the data, Havelock Ellis rightly concludes that 'the chief feature in the childhood of persons of eminent ability is their precocity.' And he continues: 'Judging from the evidence before us, there are at least three courses open to a child who is destined eventually to display pre-eminent intellectual ability. He may (1) show extraordinary aptitude for acquiring the ordinary subjects of school study; he may (2), on the other hand, show only average, and even much less than average, aptitude for ordinary school studies, but be at the same time engrossed in following up his own preferred lines of study or thinking; he may, once more (3), be marked in early life solely by physical energy, by his activity in games or mischief, or even by his brutality, the physical energy being sooner or later transformed into intellectual energy.'[1]

Of these three groups, the first—comprising those who are known to have excelled in their work at school—is by far the largest. In the second group the majority, I surmise, would have appeared equally bright could their abilities have been assessed by tests of intelligence, and the remainder were doubtless instances of specialized aptitudes or limited talents. The third group, as Ellis himself remarks, is the smallest; and scarcely any of them 'achieved very great original distinction in purely intellectual fields.' To these three we should, I fancy, add a fourth group: those whose mental development, owing to illness, accident, or other factors unrecorded, seemed at first retarded but was subsequently accelerated at an exceptional rate. Fanny Burney 'was a backward child' and did not know her letters at eight. At ten she was 'scribbling stories, farces, tragedies, and epic poems'; and by fifteen had sketched the outline for the romance that Reynolds and Burke sat up all night to read and Dr. Johnson 'knew by heart.' Chatterton up to the age of six and a half was described as 'little better than an absolute fool,' and was actually sent away from the Bristol charity school 'as a dull boy.' Then he fell in love with the illuminated capitals of an old folio; became 'an insatiable reader'; and at the age of twelve, after filling

[1] *Loc. cit.*, pp. 136, 137.

a pocket-book with lyrics for his sister, had composed the first of the long poems that perpetuate his fame.[1]

The foregoing conclusions are borne out by a more recent attempt to estimate the mental ratios of great men from a direct psychological analysis of their performances during boyhood—their early letters, their early verse, the speed with which they learnt their alphabet, the age at which they began to read, spell, calculate, recite poetry, or study foreign languages. The available data have been thoroughly sifted and winnowed, and the results impartially assessed for 300 of the most celebrated men of modern times. The outcome of the whole research has been summed up as follows. 'The true I.Q.'s (*i.e.* "mental ratios") of the subjects of this inquiry average above 160. . . . Many are above 180, while but few of them are below 140.'[2]

The fallacy which has misled so many is evidently the confusion of the scholastically backward with the genuinely dull—the unwarrantable deduction of a lack of early intelligence from a lack of early attainments. The very descriptions left by parents, pedagogues, and biographers show how easily the mistake is made. Cardinal Wiseman, says one, 'was thought dull and stupid, because he was always reading and thinking.' Scott was considered a dunce at home; Byron was called a dunderhead at school: but the very ground of complaint was that they were 'too much absorbed in reading and dreaming,' 'too much occupied with romantic ideas.' Darwin, we are told, instead of pegging away at his *Ovid* and his *Virgil*, spent the days of his boyhood hunting for rare plants among the Shropshire hedgerows and chasing moths and butterflies. Of the other names so often cited, the majority, like Hobbes, Burke, Bentham, and Dickens, were actually kept back by ill-health or disease. Thus, most of the paradoxical cases seem to be accounted for by some extrinsic factor of the type I have already discussed; the rest are explained

[1] See *Dict. Nat. Biog.*, Vol. II, p. 55, and Vol. X, pp. 144–5 and references. Many other examples could be cited: I choose Burney and Chatterton simply because they chance to be the first in alphabetical order on my notes.

[2] Cox, *Early Traits of 300 Geniuses*, Stanford University Press, 1926, p. 85.

by concentrated aptitudes or interests which left the boy impatient of the traditional routine of home or school life and absorbed in some secret line of thought or observation that was all his own.

After-Careers of Backward Children.—It will be gathered, therefore, that, more often than not, I am inclined to predict poor progress in after years for the child who makes poor progress at school. Yet I should insist on drawing a distinction, and inquiring first of all whether the failure at school was attributable to innate dullness or to some other and more superficial cause. Where innate dullness has been established by psychological tests, there the pessimistic prediction has been fully confirmed by the after-histories of those with whom I have been able to keep in touch.

I have records for 153 children, who were tested at school and found to be 'dull' in the technical sense, and who at one time or another have since obtained employment. They comprise 112 boys and 41 unmarried girls; and the records cover 10 to 15 years of after-school life. When last heard of, nearly one-third of them—32 per cent.—were reported to be unemployed. Conditions vary, however, from trade to trade, from district to district, and from year to year; so that it is difficult to say how far the lack of employment is the result of a relative unemployability and how far it is due to economic conditions. For this reason I have limited my figures to those who have obtained at least one job.

In no case has any child in the group risen to and permanently retained any high employment such as would necessitate more than an average intelligence. Eleven of the girls were sent for training as shorthand-typists; three never completed their course; four never obtained a post in this capacity; and the remainder never kept one. Nineteen boys endeavoured to enter highly skilled trades: not one retained such a job for more than six months. Of the whole group about one quarter (sixteen girls and twenty-five boys—27 per cent. in all) are doing semi-skilled mechanical work in shops, offices, or factories—work of the kind chiefly taken by the average boy; but only three are reported to be giving complete satisfaction. The rest, so

far as they have been engaged at all, have found nothing but unskilled work or coarse manual labour : errand-boys, van-boys, lift-boys, porters, messengers, casual labourers of various sorts, packers, labellers, bottlers, factory workers generally, domestic servants of the poorer type—occupations which are often well below those of their parents. During my experience in testing vocational misfits at the National Institute of Industrial Psychology I never found a single man or woman of whatever age, whose mental ratio was below 85, succeeding in work which is ordinarily supposed to require a ratio of 100 or more.[1] The dull child, therefore, seems irretrievably condemned to take up some type of employment that never demands a full quotient of intelligence.

Now let us turn to the after-careers of children who, though backward, were not dull. Here the number of reports I have so far been able to obtain are too few for detailed statistical analysis : they amount only to 63 in all. But, so far as they go, the records differ but little from those of ordinary elementary school children. It might have been expected that none would obtain or keep posts entailing an average measure of educational attainments. The majority of the backward, and practically all the dull, have remained in a state of semi-illiteracy. Nevertheless, seven or eight, since they left school, have made up for their lack of progress in the classroom. None, indeed, has risen to a professional or academic career ; and only a few have taken up clerical work. But in business, in trade, and in technical or executive work, their posts, as judged by salary, degree of responsibility, and the like, have been little if at all inferior to those of the other children from the same social class. Seventeen, for example, worked their way up to class III or IV[2] in my

[1] For the division of occupations into categories according to the degree of intelligence required, see Burt and others, *A Study in Vocational Guidance* (Reports of Industrial Fatigue Research Board, No. 33, H.M. Stationery Office, 1926, pp. 16f.). For parents' occupations see p. 120, above.

[2] Skilled, highly skilled, or clerical work : shop assistants, dressmakers, cabinet-makers, mechanics, 'bus drivers, typists, and the like (*loc. cit. sup.*, p. 16). The success of these few cases indicates what might be achieved if the backward were given continued aid *after* leaving school (cf. p. 463 and refs.).

list of vocational categories. Perhaps the additional interest taken in their case, and the special endeavours made to improve their skill and attainments just before they passed out from school, have tended largely to level them up. But I could cite several individuals who remained hopelessly backward to the end of their last school term and yet did well in after-life.

Specific Educational Abilities.—These facts and these considerations emphasize the supreme necessity for discovering first of all the innate intelligence of the backward child. If his intelligence is itself relatively weak, then the prospects are gloomy not only for his work at school but for his future career as well. If, however, his intelligence is up to the normal standard, then other causes may be suspected, and should so far as possible be cleared from his path.

Accordingly, wherever there is a marked discrepancy between the child's educational attainments, on the one hand, and his ability as revealed by tests, on the other, wherever, that is to say, his accomplishment ratio is well below 100, there it is imperative that the investigation should be pushed a step or two farther. In the simpler cases inquiry outside the school may quickly bring to light some adverse factor in the child's external surroundings—hardships at home, for instance, such as we have glanced at in the preceding chapters. Other cases will certainly arise from time to time where nothing of this sort can be discovered, and some unexplored possibility must be considered. Home conditions, bodily health, school attendance, and the like, all may prove perfectly sound. The cause, therefore, is manifestly mental; yet the ordinary mental testing has so far disclosed nothing amiss. In himself the child seems bright enough. What reason, then, can be suggested for his backwardness at school?

Let us look for a moment at the figures. Among the backward groups here studied the child's educational attainments fell 15 or more points below his mental ratio in 26 per cent. of the cases, and 10 or more points below in as many as 43 per cent. Now in this latter batch there were 29 per cent. (reckoning the percentage still on the

basis of the entire group) in whom the lack of educational progress could be explained by non-mental factors such as I have just enumerated. This leaves 14 per cent. of the total number in whom the backwardness still remains unexplained.

The next step is, therefore, self-evident, though seldom carried out in practice. We must extend our search to mental causes of a more specific nature. Already one or two of my readers may have felt disposed to doubt whether intelligence and educable capacity can always be identified. Is it not conceivable that the child's mental age may measure one form of ability, while his educational age measures another, each depending at bottom on entirely different mental functions? May it not be that school work, like so many other forms of work, requires certain specialized gifts, or some peculiar bent or aptitude?

To the conception of a special scholastic talent I am quite ready to subscribe. But I should qualify it in two ways. First, I maintain that general intelligence is always requisite as well. And, secondly, I should insist that the special aptitude for schooling is not a single, simple capacity, but a highly complex resultant—the effect of different intellectual abilities and of various temperamental traits—an amalgam, not a pure primordial element. That being so, a prolonged research may be needed to analyse where precisely the weakness of the compound lies.

The first and most obvious line to follow will be to sift over the child's achievements in each of the scholastic tests considered one by one, and to note whether his performances are uniformly poor, or whether he is far more backward in one direction than in the others. Time and again the comparison will show that, although a child may have failed to make headway in one or two particular subjects, in the rest he is nearly up to standard. All such cases raise the question we are now propounding in its sharpest form, and constitute some of the most perplexing problems with which the teacher has to deal. Tommy A., for example, aged 10½, is quite able to do the sums that are taught in standard IV, and is intelligent enough to hold his own in all the oral lessons of his class; his reading,

however, is barely equal to that of an average seven-year-old in standard I. Lizzie B., aged 12½ and working in standard VI, can read, spell, and write English compositions, in a way that would do credit to any girl in her standard; but her arithmetic is appalling, as poor as that of the little eight-year-olds in standard II. What can be the reason for this singular unevenness? And what is the teacher to do for such anomalous youngsters as these?

Special Psychological Abilities or 'Group Factors.'—To the psychologist actual examples of this type are of deep theoretical interest. They substantiate in a concrete way the hypothesis deduced from a purely statistical analysis of experimental results. As I have already intimated, a child's educational attainments appear to depend, not only upon general intelligence—the common factor entering into every form of intellectual work—but also upon certain more limited capacities, differing for different subjects. What are the particular capacities which the statistical data suggest? As applied to the results of scholastic tests, the method of partial correlation discloses at least four specialized abilities, each of direct importance in the elementary classroom: arithmetical, verbal, literary, and manual. Of all these 'special' or 'group' factors (as they are variously termed) the *arithmetical* is the best established. The various forms of arithmetical work seem to constitute a single group of allied activities; and proficiency in one branch is correlated with proficiency in the others specifically—that is, to a degree which cannot be explained entirely by the general factor of intelligence. Reading and spelling form a second semi-independent group of subjects, involving yet another specialized ability: it may be described as a *verbal* or linguistic factor. A third group, not entirely unrelated to the second, comprises those subjects in which composition plays a part: essay writing, the study of English literature, of history, of geography, of informational subjects generally, all require what may be called a *literary* factor. Fourthly, ability in drawing, in handwriting, and in various forms of handwork go closely together, and imply the existence of a *manual* factor. In addition to these four, there is a small amount of evidence

for other special factors entering into subsidiary branches of the curriculum: mechanical ability, musical ability, and perhaps the pictorial forms of æsthetic appreciation and artistic execution, seem to rest each upon peculiar factors of their own.[1]

The practical bearing of this hypothesis is clear. To excel in arithmetic the pupil needs, not merely a high degree of general intelligence, but also a high degree of the specific aptitude for working with numbers. Conversely, to be backward in arithmetic may mean that the child is lacking either in general intelligence or in the specific aptitude, or possibly in both. Similarly for all other specialized forms of intellectual work. Moreover, the fact that individual case-studies so often furnish examples of precisely those localized types of backwardness which the theory demands is itself a valuable corroboration. Thus the work of the statistical psychologist at once explains, and is confirmed by, the work of the practical psychologist in the school and in the clinic. In every case, therefore, it becomes of vital importance to determine whether the child's educational disability is general or specific, and never to assume off-

[1] For simplicity I have described each as a specialized 'ability.' But every one of these specialized abilities is no doubt highly complex—a set of abilities, rather than a single or simple capacity. The evidence for preferring a 'multiple factor theory' to Spearman's 'two factor theory' was first given in *The Distribution and Relations of Educational Abilities*, 1917, pp. 56 *et seq.* The 'factors' there demonstrated have been amply confirmed by recent work (cf. *Brit. J. Educ. Psych.*, IX, pp. 45–71, and above, p. 74). We may thus distinguish 'types' of special disability—the verbal type, the number type, the manual type, the memory type, and so on. The so-called 'types,' as I have elsewhere pointed out, are merely tendencies; and the degree to which each child tends towards a given 'type' may in theory be measured by correlating, not the tests, but the children. Thus, a child suffering from verbal disability is usually worst in spelling tests, nearly as bad in tests of composition, and not quite so bad in tests of reading; he will doubtless be worse in tests of problem arithmetic than in tests of mechanical arithmetic, but better in both of these than in any of the literary subjects. The child suffering from defective memory is usually worst in spelling and in mechanical arithmetic. The order of difficulty for the different subjects is thus different for the different types, and forms as it were a pattern characteristic of each one. These peculiarities, however, can perhaps be brought out best by plotting the test results for each child as an educational graph or 'psychogram' (cf. *loc. cit.*, p. 65, fig. 9, for illustrative instances).

hand that he will be incapable of progress in all other directions because he is backward in one.

With the ultimate causes of disability in arithmetic and in reading I propose to deal in a later volume. Here I am concerned with these specialized defects only in so far as they themselves are liable to cause an apparent backwardness all round. Among the children examined in London during the present inquiry there were at least twenty cases where the general backwardness was attributable to a specific disability in reading, and at least ten where it was attributable to a specific disability in arithmetic—proportions of 5·2 per cent. and 2·6 per cent. respectively.[1]

How does this come about? Why should a disability in one subject spread to all the rest? The case-histories will generally unfold the answers to these questions.

In the elementary school, children are not re-classified for different subjects: the ability of any one child is tacitly supposed to be much the same for every subject of the time-table. Hence there is a temptation to allocate each pupil according to his weakest subject, particularly if that subject depends on collective teaching. Winnie, in reading and composition, is quite equal to standard V, but her arithmetic is barely that of standard III, so she is sent to standard III for all subjects. Walter's reading is little better than that of an infant of seven; but, although in arithmetic, and indeed in every other subject except perhaps spelling, he could make the same progress as a

[1] Strictly speaking, I understand by specific disability in one school subject a mental age for that subject of less than 85 per cent. of the child's average attainments in all other educational subjects. Thus, whether his chronological age was 6, 8, or 10, a child whose educational age in arithmetic was 8·4, and whose educational age in reading, spelling, composition, writing, drawing, and handwork averaged 10·0, would be termed specifically backward in arithmetic. With the backward readers spelling is ignored in calculating the average educational age, since a backwardness in reading is almost automatically followed by a backwardness in spelling.

In dealing with a backward group, however, the diagnosis has usually to be made from a study of each child's school history, not merely from a comparison of his educational attainments at the time he is tested: for, as I have pointed out above, backwardness in special subjects tends gradually to produce a backwardness all round. In point of fact, the figures in the text probably underestimate the number of cases due to causes of this kind.

normal lad of eleven, he likewise remains in standard I for everything. To keep these two down in a class which is two or three standards below their general level simply because there is one particular lesson in which they cannot get on, may at first sight seem grossly unfair ; yet, if they are placed in a standard that corresponds with their attainments in other studies, what can they do during the hours for reading or arithmetic ? Unless the teacher can give them individual attention or at least arrange for them to do individual work, they are likely to idle, and will certainly be unable to keep pace with the rest. As a consequence, in spite of its apparent injustice, promotion goes usually by the pupil's poorest subject, not by his average or his best ; and a child who is backward in one branch of the curriculum is kept back for all the others. Should his disability be severe and his progress slow, in course of time he may drop so far behind his fellows that some fresh teacher, unaware of his past history, thinks the boy is dull all round and perhaps even mentally deficient. Indeed, among the cases referred to me on grounds of suspected mental deficiency I find quite an appreciable proportion suffering from nothing but limited and specialized disabilities of the kind I have described—backwardness in arithmetic and number, for example, or (most frequently of all) a disability in reading.

Backwardness in arithmetic appears as a cause of general retardation chiefly among the older pupils, and particularly among the girls. In many schools promotion still goes mainly by the results of the terminal examinations in this subject. It is the easiest to test ; and the standards of attainment at each age of school life are well defined and fairly well known. Further, in arithmetic the elementary syllabus forms a consecutive whole in which each phase rests upon the last, like a pyramid of graduated boxes. To skip one stage is to imperil the remainder. Accordingly, in the higher classes more especially, where teaching has passed beyond the four fundamental processes, independent work on paper becomes almost an impossibility, unless the pupil can follow the explanations of the new rules ; and each new rule in its turn presupposes a thorough grasp

of the preceding. Hence awkward complications would ensue from moving up a child, however bright, to a standard where the arithmetic was beyond his present reach—where he would be required, for example, to start decimals although he had not yet mastered long division and ordinary fractions. As a result, a child of twelve or thirteen may often be kept down in standard IV or V because of his weakness in sums, no matter how advanced his knowledge may be in other branches of the curriculum.

Backwardness in reading would seem to be almost twice as common as backwardness in arithmetic, certainly among the retarded groups. Here it was found more frequently among the boys than among the girls. In the control group no cases whatever were observed among the girls.

A disability in reading operates in a more general way than a disability in arithmetic. From the earliest years the child is heavily handicapped. If he cannot read a word, he is not likely to spell it ; and if he cannot spell, he is hopelessly at a loss in written composition. Further, the poor reader will eventually become backward in arithmetic as well, simply because he cannot make out the problems written on the board or printed in his textbook. For a similar reason, as time goes on he will fall behind in all other studies that depend upon book-work—geography, history, and even nature-study and science—indeed, wherever reading, note-taking, and essay-writing are required. Both these abilities—reading and arithmetic—are acquired : though fundamental for education, they are not fundamental for the psychologist. We must therefore now consider what special abilities, inborn rather than acquired, are likely to conduce to disabilities of this type or to educational backwardness generally.[1]

[1] The hypothesis of an innate general factor has so often been criticized (cf. A. W. Heim, *The Appraisal of Intelligence*, 1954, and refs.), and the arguments in its support have so frequently been misstated, that a summary of the evidence seems necessary here. Three points require separate proof :

(1) The hypothesis of a *general* factor rests on four converging lines of evidence : (i) the *observation* of human behaviour strongly suggests (as Aristotle, Johnson, Carlyle and other shrewd observers have maintained) that the most able individuals are able all round, and the most unintelligent

are unintelligent all round; (ii) *biology* (as Spencer first pointed out) seems to indicate that, during the evolution of the animal kingdom and during the development of the individual child, a general cognitive or 'directive' capacity (which he called 'intelligence') emerges earliest, and out of it a hierarchy of specialized abilities gradually differentiates later on; (iii) *neurology* demonstrates that the brain is not subdivided into separate 'organs' or 'centres'; in the same individual the structure of the nervous system, whether efficient or inefficient, is of the same general character throughout, though certain areas become progressively specialized during growth and maturation; (iv) *statistical* research confirms this double assumption of general *plus* special abilities (see pp. 683 f.).

(2) The 'general' factor covers *cognitive processes* only, not affective or conative. For evidence the earlier psychologists relied mainly on (i) *introspection.* (ii) Evidence from other sources (*observational*, *biological*, and *statistical*) supports the same conclusion, provided we interpret the term 'cognitive' behaviouristically as covering practical as well as purely intellectual activities. It would be clearer to designate the factor 'directive' (as distinct from 'motivational') or 'cybernetic' (as distinct from 'dynamic').

(3) The factor is *innate.* Those who have questioned this view generally assume an entirely out-of-date conception of what is meant by 'hereditary' or 'innate.' (i) *Biological* research shows that, both in animals and in man, most of the traits exhibiting continuous variation are the effect chiefly of what Mendelian writers term 'multifactorial inheritance.' Hence it is natural to infer that variations in neural structure (as in all other structures) must depend on the same type of genetic transmission. (ii) *Experimental* work on the breeding of animals whose abilities can be tested, though meagre, strongly confirms this hypothesis. (iii) With human beings, however, *Statistical* investigations alone are practicable: (*a*) where *Environment* is relatively constant (*e.g.* with children brought up in orphanages from infancy) wide differences in intelligence are still found, correlated with those of their parents; (*b*) where *Heredity* is constant (*e.g.* with 'identical' twins brought up in very different environments) differences in intelligence are far more closely correlated than in non-identical twins or ordinary sibs, brought up in the same environment; (*c*) *Analysis of Variance* demonstrates that the form and range of the frequency-distributions and the figures for correlations between different degrees of kinship, deduced on the basis of the Mendelian hypothesis (in the composite form suggested in the text, p. 442), yield an excellent fit to the observed data, whereas those deduced from alternative hypotheses do not (for a fuller discussion see Burt, 'The Evidence for the Concept of Intelligence,' *Brit. J. Educ. Psychol.*, XXV, 1955, pp. 158–77; Burt and Howard, 'The Multifactorial Theory of Inheritance and its Application to Intelligence,' *Brit. J. Statist. Psychol.*, IX, 1956, pp. 95–131; X, 1957, pp. 33–63).

CHAPTER XIII

INTELLECTUAL FACTORS

B. *Special Disabilities: Perceptual*

Elementary Specific Capacities.—The psychology of special abilities is unfortunately still in its infancy. All psychologists, even those who deny the existence of general intelligence, appear to admit the existence of specific aptitudes. But what precisely these aptitudes are, and how specific their effects may be, are problems on which there is as yet but scanty evidence. At the moment the trend of the best psychological opinion is to distrust the hypothesis of so-called 'faculties'—general powers of observation, attention, memory, and the rest—and to hold that intellectual functions are far more specialized and restricted than teachers, medical writers, and even psychologists themselves, have hitherto assumed.[1]

We should, therefore, beware of hasty generalizations. Before invoking some supposedly simple defect in verbal capacity or in manual dexterity to explain some particular case, or before putting down a child's poor progress to sheer lack of memory or attention, we must inquire whether the analysis cannot be carried still further. Every one of the separate capacities to which popular speech has given a special name appears to be but partly independent of the rest; and each is undoubtedly complex. On the other hand, capacities that are genuinely self-contained seem in most cases to be remarkably specific. Accordingly, to discover that a child's disability is localized and not wide-

[1] I have endeavoured to review the evidence up to date in my pamphlet on *The Measurement of Mental Capacities* (Henderson Trust Lectures, No. VI, Oliver & Boyd; new edition in the press). Spearman's account of the subject in *Abilities of Man* (1927) underestimates the importance of special abilities and disabilities. For the results of more recent investigations see *Brit. J. Educ. Psychol.*, XIX, 1949, pp. 176–99.

spread is only the first preliminary move in the unravelling of his trouble ; and to disentangle and investigate all other essential abilities besides his general intelligence will evidently be a long, elaborate, and decidedly formidable task.

Analysis of Special Disabilities.—Let us suppose, then, that we are faced with a backward pupil whose intelligence is perfectly normal. His home circumstances are excellent ; he has attended regularly at school ; his health and physical development are sound, and his temperament stable ; he is known to be a keen and conscientious plodder ; and there is nothing whatever in his history to account for his poor achievements. It is obvious that, intelligent as he is, his efforts must be continually frustrated by some unsuspected obstacle that keeps him from mastering his work. How are we to proceed ?

The ideal plan would be this. We should examine his special intellectual activities in turn, beginning with the most elementary processes first of all, such as those of sense-perception and the simpler motor reactions, and then working progressively upwards to the highest levels—the processes of logical thought and reasoning. For a complete psychological examination, every conceivable capacity should be tested, and the results expressed in exact quantitative terms. So full a programme is impracticable. For many functions of the mind we have as yet no standardized methods of measurement, and most of the existing methods are far too cumbersome for use outside the laboratory. Nevertheless, for the more important of the intellectual processes called into play in the classroom, a few simple tests are already available : and, though it is often doubtful whether such tests really isolate the capacities after which they are familiarly named, they enable us to watch more clearly certain aspects of the mind at work, in definite and comparable situations.

I shall have space only to touch upon the simplest and the most suggestive ; and I shall summarize very briefly both the methods and the results. For the main investigation described in this volume a number of tests were selected as being likely to elicit special disabilities of this kind. It

was not, however, feasible to apply them to every single child in the backward and the normal groups. They were used primarily as a means of examining particular cases—children in whom specific disabilities were suspected or in whom no other ground for backwardness could be discovered. But, for the sake of comparison, fairly representative samples were also tested among both the backward and the control group. These were mainly older children; and, with most of the tests, about fifty boys and fifty girls were examined from each of the groups. By application to median children outside the experimental groups, the results were first of all standardized in the ordinary way;

TABLE XXIII. TESTS OF SPECIAL INTELLECTUAL ABILITIES

Average Performances in Mental Ratios

	Control Group.			Backward.		
	Boys.	Girls.	Average.	Boys.	Girls.	Average.
Visual Perception	98·1	96·1	97·1	97·0	95·9	96·5
Auditory Perception	94·4	97·6	96·0	89·4	91·0	90·2
Scope of Attention	95·4	94·5	94·9	85·9	88·6	87·3
Duration of Attention	96·2	95·7	95·9	86·3	83·4	84·9
Speed of Association	89·5	90·6	90·1	82·8	88·0	85·4
Mechanical Memory (Immediate)	98·0	100·1	99·1	83·7	84·5	84·1
Mechanical Memory (Delayed)	93·7	96·9	95·3	77·2	79·1	78·2
Logical Memory (Immediate)	94·5	98·0	96·3	81·8	87·2	84·5
Logical Memory (Delayed)	96·0	97·9	96·9	82·3	85·5	83·9
Reasoning	93·1	94·2	93·6	78·3	76·1	77·2

and mental ratios and percentages were then calculated for the selected samples (see Tables XXIII and XXIV).[1]

According to the usual principle, we should regard a child as technically backward in the capacity tested if his per-

[1] Except for the cases of special disability, which I nearly always tested personally, a large amount of the testing—particularly the routine work necessary for standardization—was carried out by research-students, or students specializing in educational psychology, at the London Day Training College (now the Institute of Education). I have to express my thanks to them for the ready way in which they co-operated in the research. It was, however, designed merely as a preliminary and tentative investigation, to ascertain how far these specialized tests were likely to yield results of theoretical or practical value. The data here recorded, therefore, cannot be regarded as highly precise.

formances were poorer than those of a child having less than 85 per cent. of his own chronological age. Naturally, however, there is often a close correlation between the measurements in these tests and the child's general intelligence. Hence it becomes necessary to make some allowance for a lack of intelligence with those who are definitely dull. I have, therefore, adopted the following broad criterion. I have recorded a child as suffering from a *specific* disability in these particular processes if his performances are poorer than those of a child having less than 85 per cent. of his *mental* age.[1] Calculated on this basis the percentages for both groups are given in Table XXIV (p. 468). Were my cases more numerous, it would have been desirable to divide the retarded into two sub-groups—the dull and the backward respectively—and, in particular, to tabulate separate figures for the incidence of specific disabilities among the latter. Unfortunately, however, the two sub-groups would be here too small for a thorough statistical comparison. Except in one or two rare instances, the differences so reached, though frequently suggestive, have a probable error much too high to render a more detailed tabulation worth while until further data have been collected.

In the tables and in the text I shall record and discuss the test-results under short psychological headings. But it will, as a rule, be unwise to conclude that these headings are anything more than convenient titles under which

[1] The word 'disability' is not used to imply anything morbid or pathological. I should prefer the word 'difference.' But some differences favour, and others hinder, the work of the school child; and the word 'disability' is here employed as a serviceable term to designate the latter. I should explain that fifteen years ago, when this investigation was planned, I anticipated more from the actual test-measurements than I have since learned can be deduced. As time went on, I found the practical hints furnished by the tests about each individual child far more suggestive than the quantitative data obtained for the groups as a whole. For this reason, and owing to the pressure of other work, the somewhat elaborate programme for statistical comparison has been greatly curtailed. Statistical comparisons in the future will, it is clear, be forced to proceed, not by studying large and complex problems in the mass, but by making intensive studies of particular points and special aspects. I hope, however, that the preliminary survey given here may prove enlightening both to the practical teacher and to the theoretical investigator.

TABLE XXIV. PERCENTAGE OF CHILDREN BACKWARD IN SPECIFIC INTELLECTUAL ABILITIES

	Control Group.			Backward.			
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	Correlation with Backwardness.
Educational:							
Reading	2·0	0·0	1·0	6·6	3·8	5·2	·38
Arithmetic	0·5	1·0	0·8	1·6	3·5	2·6	·25
Psychological:							
Visual Perception	2·6	3·5	3·1	4·2	5·6	4·9	·11
Auditory Perception	10·9	5·4	8·1	23·2	13·6	18·4	·28
Scope of Attention	3·6	4·0	3·8	12·4	10·1	11·3	·31
Duration of Attention	3·1	4·6	3·8	11·9	15·2	13·5	·37
Speed of Association	18·8	9·6	14·2	19·5	12·6	16·1	·04
Mechanical Memory (Immediate)	1·0	1·0	1·0	10·4	6·6	8·5	·51
Mechanical Memory (Delayed)	1·5	1·0	1·3	17·6	11·6	14·6	·60
Reasoning	0·5	1·5	1·0	8·3	13·1	10·7	·57

certain facts can be grouped. Even where the existence of a specific and independent capacity may be validly assumed, one or two tests would scarcely suffice to measure it. A brief description of such tests, however, will serve several purposes: it will elucidate better than any formal definition the nature of the mental processes involved and the meaning the psychologist attaches to such words as attention, memory, and the like; and it will help the teacher to understand the lines upon which future psychological studies are likely to proceed. To the more regular workers in these fields the actual use of such tests will not only afford a ready starting-point for exploring the child's mind in certain well-defined directions; it will also aid them to keep their standards of comparison more nearly uniform. But the measurement of mental functions is here the least valuable and the least trustworthy part of all such experiments. The supplementary tests that I shall suggest are to be regarded rather as handy devices for observing the child at work. Seeing in the concrete his mode of attack, noting his errors, finding the reason for his slips, getting him to explain the special points that

bother him, trying first this approach, then that, and watching which fails and which is successful, all this will shed a far clearer light on his mental disabilities than routine measurements and quantitative results. It is much more by these incidental clues than by a mere comparison of figures and norms that we can hope eventually to track down the real source of the trouble in any particular case ; and it is with this main object in view that I shall briefly describe some of the simpler methods here.[1]

Sense-Perception.—The simplest and most fundamental processes of all—those of sensation on the one hand and of movement on the other—we have already discussed. Tests of vision, of hearing, of muscle sense, and of motor dexterity and quickness, have been described in the previous chapters. With the intelligent child who learns little or nothing in the classroom one of the first questions to be asked is—how far can he see and hear the things he is expected to learn ? Hitherto we have dealt with sight and hearing as if they supplied nothing but mere sensations: we have treated the tests as physical tests rather than as mental tests, because our primary concern was to discover defects in the bodily sense-organ.

In practical life, however, seeing and hearing imply very much more than possessing sound eyes and ears. The sensations they yield have first to be interpreted ; and what is popularly called sensation is really sense-perception. When we look at a picture or listen to a voice, what in the end we actually perceive depends quite as much on the contribution of the brain or mind as upon the mere sensory impressions picked up by the external sense-organ.

[1] In connexion with the above inquiry, several of my research-students at the Institute of Education have endeavoured to standardize such tests and to determine their value in relation to the special subjects of the curriculum : among these I may mention more particularly the work of Miss Gertrude Hume on reading, of Miss Elizabeth Wheeler on arithmetic, and of Dr. F. J. Schonell on spelling. Their original investigations are fully described in theses as yet unpublished ; but the theses are accessible at the University to those who wish to consult them. Dr. Schonell has recently reviewed the whole problem in a series of brief articles contributed to the *Year Book of Education* for 1934 (reprinted in *The Testing of Intelligence*, edited by H. R. Hamley, Evans Bros., 1935, pp. 80–113).

Thus a child's eyesight may be perfectly normal; yet he may still fail to discriminate the various forms and shapes that confront him in his ordinary school work. He may confuse such printed letters as *H* and *N*, *b* and *d*, *p* and *q*, or an *s* written correctly and an *s* written mirrorwise.[1] Most frequently this springs, not from any defective acuity in the eye itself, but rather from some trouble over analysing and distinguishing the tiny complicated patterns that the eye can focus quite clearly. Similarly, when the child tries to compare or analyse the words that he hears—as, for example, in thinking out their spelling—much the same difficulty of discrimination may arise; hence, once again, perceptual discrimination has to be considered apart, over and above the mere acuity of hearing.

Observation.—In everyday life, visual perception as thus defined forms the essential element in what is popularly called observation. We contrast the observant with the unobservant man. The marks, the clues, the tell-tale signs, were equally visible to Dr. Watson and to Sherlock Holmes: and the best of spectacles would not have helped the good doctor to appreciate what he was looking at but failed to see.

Tests for measuring the power of observation have been attempted by several psychologists. The best-known are those of Binet. These have frequently been applied to school children. A picture representing some interesting scene, or some simple object like a box of matches or a post-marked stamp, is placed before the child; and he is asked to describe it. Sometimes a number of objects or pictures are pasted on a card; the card is exposed for half a minute, and the child has then to write down all that he saw. The method is reminiscent of the tray of articles used for training Kim in Rudyard Kipling's story. In my own investigation I have used first a picture-test and secondly a card of objects, following in either case the procedure standardized by Whipple.[2] The results of these

[1] Cf. *sup.*, pp. 350 *et seq.*

[2] See Test 31 ('Description of an Object, Method 1'—with oral instead of written narrative, supplemented by an interrogatory, along the lines of Test 32B) and Test 32A (Report-test with Binet's card of objects).

tests were collated with notes on each child's apparent power of observation as displayed in the course of other tests and during the whole examination.

Judged by the average performances and the general percentages,[1] there was no great difference between the normal and the retarded. Indeed, the dull often proved far quicker in such tests than their intelligence would have led one to expect. The London street-arab learns to use his eyes ; and his smartness in this direction may sometimes lead others to imagine that he is bright all round. No clear examples of specific deficiency were observed. To some extent, too, the weaknesses revealed by these tests were not so much difficulties in perception as in verbal description : even when the dull child is sharper than the normal child over noticing points in the picture, he may at times be far more clumsy in putting what he sees into words.

In a few anomalous cases, however, the individual results were highly instructive ; and here the children's successes were almost as significant as their failures. In the first place, I repeatedly found the test-performance of great help in explaining hints and comments dropped by the parents or teachers. Time after time, especially with the very young, a teacher would report that a backward child 'showed great cleverness in observation,' or a parent would declare that her boy 'was quite 'cute and shrewd over noticing practical things' ; and these gleams of brightness were erroneously taken as proof of a high, all-round ability which the child refused to apply to his regular work in school. In such a case the child's success with these particular tests would often confirm the teacher's impressions ; but, being specific, or at any rate yielding very different results from the tests of general intelligence, they served to correct his mistaken deduction. Secondly, not only in these instances, but also in others where the child's powers of observation had remained unnoticed, the findings would often point with no uncertain finger towards a fruitful line of approach along which the child's instruction might hopefully proceed. Where, on the other hand, an apparent weakness was revealed, it seemed sometimes to

[1] See above, Tables XXIII and XXIV, pp. 466 and 468.

explain the astonishing ignorance of the everyday world around him that the child regularly showed in the classroom. With these children the underlying defect was usually temperamental rather than intellectual: they were, for the most part, absent-minded introverts, living largely in a universe of their own. In others the defect seemed closely related to the peculiar difficulties the child experienced in reading. For the perception of letter-shapes and word-forms, however, a special set of tests was employed which I need not here discuss.[1] All through a clear sex-difference was noted, and, indeed, was far more marked than the difference between the retarded and the normal groups. In general, the observation of the boys was more accurate in its content and wider in its range than the girls'. Tests of observation, however, are already familiar to teachers in the infants' department; and accordingly I need say little more to urge their value as a mode of approach in studying the backward child.[2]

Analysis of Sounds.—What I am tempted to call observation through the ear, as distinct from observation through the eye, is a capacity which is but little cultivated in ordinary everyday life. Everyone is expected to recognize a familiar book when it is placed on a shelf among others; but even teachers of music may fail to pick out a familiar tune—'God save the King,' for example—when played in an inner part. During childhood auditory perception has a vitally important rôle in learning to speak, read, and spell, and, indeed, in grasping verbal instructions and oral lessons generally: yet it is rarely tested in the schoolroom.

Instructive tests may be modelled on the exercises used by phoneticians for what they term ear-training. A graded list of nonsense-words—increasing in length and complexity—is called out to the child, and he has to repeat

[1] When the material to be observed consists of meaningless objects and arbitrary symbols differing but little in shape, the dull and backward are often much below the average. But a description of the modified tests belongs rather to an analysis of specific backwardness in reading.

[2] For a detailed and interesting account of such tests, applied to London school children, see W. H. Winch, *Children's Perceptions: An Experimental Study of Observation and Report in School Children* (1914).

or write what he thinks he heard. In class-exercises for older students phonetic symbols are used. With the young, and particularly with the dull and backward, to write the sound from dictation, even when ordinary letters of the alphabet are allowed, greatly complicates the difficulty of the task. Accordingly, in the tests I have employed for this purpose the child is first asked simply to repeat the sounds ; and then (since incorrect repetition might result from motor inaccuracy as well as from auditory inaccuracy) he is asked to listen to pairs of nonsense-words and to judge whether they are identical or slightly different ; and finally, merely as a supplementary exercise, he is asked to write them down as best he can.

Among those who were merely backward, three of the more intelligent children were discovered to be singularly obtuse in analysing the spoken sounds that they heard. They omitted or inserted sounds ; they interchanged the order ; and they seemed to experience a curious difficulty in connecting audible sounds with written symbols. Among the dull this last peculiarity was noted more frequently still : it may be, of course, a difficulty of association rather than of mere auditory analysis. With the dull, however, the absence of meaning in the auditory test-material proved an added source of confusion ; many were very apt to assimilate the nonsense-words to sensible words in their accustomed vocabulary. This possibly accounts for the high percentage of deficiencies for auditory perception as contrasted with visual perception shown in Table XXIV (p. 468) : as I have already implied, the dullard, when required to discriminate meaningless visible material (as distinct from the intelligible pictures or familiar objects chiefly used in my tests), may be almost as poor with the eye as he is with the ear.

Of those who seemed to be specifically defective in auditory perception, the majority were children already known to be backward in reading. A few had been independently noted by their teachers as 'slow in the uptake': apparently they found it hard to comprehend any explanation or instruction conveyed to them by speech.[1]

[1] An interesting case of this type was noted, not among school children, but in a college student : this man complained that he followed lectures,

Several showed minor defects of speech themselves—mostly defects of pronunciation suggestive of muddled rather than weak hearing. Of those picked out by this test a small proportion proved to be on further study instances of what I have described already as high-note deafness. How far such deafness is due to a defect of the ear and how far it is of central origin, is unknown: probably the causes differ in different cases.[1]

A definite auditory test along the lines just explained above is strongly to be recommended for practical use in the school. It forms an invaluable supplement to the usual tests for hearing. Children whose performances appear to be well below the average should be referred for expert examination by a specialist to check the possibility not only of defective acuity but also of deafness for high tones.

Illustrative Case.—The shortcomings revealed by these different tests for visual and auditory perception no doubt have a mixed and variable origin. In some cases they may be due simply to an habitual lack of attention to the type of material involved, springing perhaps from a lack of interest or pleasure in it. In other cases, by no means numerous it must be admitted, the defect seems to run in families; and there is at least a *prima facie* ground for suspecting here and there the inheritance of some underlying disability. I may perhaps usefully recount a somewhat remarkable example which may illustrate the problems that are commonly raised, and generally remain unsolved, in work with children of this type.

The boy in question was not one of the backward children analysed for the purposes of this research. He was attending a secondary school. He had entered at the age of twelve as a fee-paying pupil. Six months later he was sent to me as unfit for a secondary education. The master reported: 'He has no memory. His ignorance even of the most

and even ordinary conversation, with the greatest difficulty, but could grasp the same ideas immediately if he read them in print or writing. Similar complaints are not uncommon, but in this instance the disability was extreme. On testing him I found him to have remarkably poor auditory perception of almost every kind.

[1] See above, pp. 249 and 386.

ordinary facts is astounding. He seems well grounded in the rudiments. But his English compositions are so full of absurdities that we think he must be mentally defective.' At home the two points that the parents observed and complained of were, first, that the boy 'often seems lost—he pays no attention when you speak to him'; and secondly, that his letters to relatives were all so shockingly misspelt. The family doctor, influenced by the recollection of a difficult confinement and birth, had suggested that the boy might be 'word-deaf, owing possibly to the compression of the skull.'

I examined him first of all with the usual tests of educational attainments. The salient result was an exceptional unevenness in his various performances. His best subject was arithmetic: here he had a mental age, both for mechanical work and problem work, of over thirteen. In mathematical reasoning he was unexpectedly quick; nevertheless, from time to time he would offer a ludicrous answer which the common sense of a child of seven would have been sufficient to reject. In the tests of reading his scores were very unequal. His speed and fluency were remarkably good, quite up to those of an average boy of fourteen. His accuracy, however, was that of a ten-year-old, his blunders being for the most part wild guesses at words that he did not stop to analyse. In tests of comprehension he reached a mental age of twelve. But this hardly represented his true capacity. Abstract matter he could reproduce astonishingly well; concrete matter had little interest or meaning for him. Most of his time at home, I gathered, was spent poring over books; but his favourite literature consisted, not of fiction, but of scientific or philosophical works borrowed from his father's library.

In English composition he acquitted himself quite as well as a normal child of thirteen. The subject set was 'School'; and this he discussed, not from first-hand experience, but in an aloof and abstract fashion as a social institution. Here, as elsewhere, all that he wrote was studded with mis-spellings—chiefly slips and improvisations such as might be made by a youngster of nine or ten. His handwriting was painfully neat, and as regular and

well-formed as that of a youth of fifteen. His drawings were more like the productions of a ten-year-old. The execution was good; but there was little detail in what he drew, and the parts were ludicrously out of proportion. A careful review of these results, it will be seen, yields a far clearer picture of the trouble than the incidental observations of the classroom. Judged by the quantitative results, the boy is not really backward, though he shows many of the superficial defects of the backward child.

Further testing, more specifically psychological, was needed to interpret these various peculiarities. In general intelligence his mental age proved to be 13·0 years; and in tests of reasoning he did almost as well. This yields no explanation of his disabilities, but it enables us at once to dismiss the master's mistaken inference. So far from being mentally defective, the lad is slightly above the general average, though not, of course, equal to the scholarship winners who formed a fair proportion of his school.

Accordingly, we must turn to tests of more specialized abilities such as I have been describing. By a casual examination it would have been difficult to decide whether the boy was in any way slow in hearing. Special examination was essential. As a matter of fact, on the recommendation of the family physician, the boy had been taken to an ear specialist, who reported: 'Hearing normal; cerebral deafness possible, but no clear signs observed.' Tests of auditory perception were therefore tried to begin with. The results showed that, alike in auditory acuity and all forms of auditory perception, the boy's capacities were perfectly normal. Moreover, on going into the early history of the child, the details plainly ruled out the possibility of any injury to the brain at birth such as the otologist and the family doctor had suspected. Indeed, on the physical side the boy's development and general condition had always been exceptionally good. In tests of mechanical memory he showed himself remarkably retentive. In tests of imagery he appeared to be an audile, but in visualization seemed rather weaker than the average boy of his type. In

short, the only serious defects that could be discovered were those revealed by tests involving visual perception. But here his failures were most impressive. At every point his performances were poorer than those of an average child of nine. When shown a picture, he could recall but one or two items at most. For example, in the picture-completion tests he took little account of the shapes of the objects represented : nearly always he attempted to fit the pieces together by their colour alone. In working out Healy Puzzle A, he constantly tried to thrust the larger strips into holes that were manifestly too small for them. In drawing, when asked to sketch the front of his house, he produced a square containing six narrow oblongs, set in a row, to represent the windows. He knew there were six windows, he said, because he had once counted them ; but he had never noticed that they were arranged, not in a row, but in pairs above each other. When told to put in the door, he failed completely. He was equally lost when asked to describe the appearance and the contents of his dining-room at home. Of what he had seen on the way to my office he could remember nothing, and almost as little about the streets that he passed through day by day on his journey to school.

The results of these special tests, together with the points incidentally noted, explained much that was strange in the child's erratic work. The master was wrong in attributing his ignorance to lack of intelligence or memory. If it was justifiable to generalize at all, the lad should have been described as suffering, not from lack of memory, but from lack of observation. His eyesight was perfect ; yet he evinced a singular incapacity for perceiving or apperceiving the detailed constitution of any concrete object presented in visual form. To speak of this incapacity as a simple unitary defect, fundamental and innate, may certainly seem rash ; yet it is suggestive to note that the mother mentioned three other male members of the family—the boy's father and two uncles—who were, as she put it, 'extraordinarily absent-minded' and 'could not see what was in front of their eyes.' The father, a clerk with a responsible position in a bank, was good enough to submit to

some of my tests. He showed much the same shortcomings as his boy, and to nearly the same exceptional degree.[1]

With the boy himself the visible aspect of things seemed to convey little or no meaning; and this in turn had apparently deprived him of a normal interest in all he saw in the everyday life around him; hence he had become habitually unobservant. Partly as a result, partly perhaps as a contributing cause, he was leading a solitary, dreamy, and introverted life, and had grown up woefully ignorant of the simplest aspects of the outside world. Though he could argue intelligently on abstract issues, his daily perceptions had supplied him with no collection of facts by which to check his conclusions, and no fund of concrete knowledge by which to interpret what he heard or read.

It will be noted that tests such as I have been describing depend essentially, not upon the efficiency of the eye or the ear itself, but rather upon a power of attentive analysis as applied to visual or to auditory material. To perceive is to apperceive; and to discriminate is to attend. Hence, in watching a child's actual procedure, alike in special tests and in the ordinary work of the classroom, it may often be observed that where he really seems to fail is not in seeing or hearing, but in attending methodically to what he sees and hears. This is most conspicuous in those extremer cases of dullness that border on mental deficiency. Such children are, as a rule, singularly slow in the uptake and the intake. Though the things in front of them are concrete and sensorial, they fail both to apprehend and to comprehend. They receive sensory impressions, but attach no clear meaning to them, nor do they immediately organize them into any intelligible whole. This suggests that our tests of perceptual capacities must in part be tests of attention, and might well be supplemented by more direct efforts to test attention in and for itself, particularly with concrete or perceptual material.

[1] In most cases of this kind I am inclined to suspect the inheritance of a temperamental rather than an intellectual peculiarity. But here the tests strongly suggested that the intellectual disability was primary. However, speculations about the inheritance of specific mental traits is nearly always rash.

Attention.—Of all the alleged elementary capacities of the mind, the one of which the teacher most frequently complains is, in point of fact, attention. Attention, however, is a term of popular psychology which psychologists themselves are reluctant to employ. It may mean so many different things ; and some are disposed to think it means nothing at all. Many, I fancy, would question whether there can be any such thing as an efficient test of attention ; and not a few would rejoin that every intellectual test is of necessity a test of attention, since attention is nothing more than the conative aspect of all cognitive process : it implies effort in things intellectual.

Accordingly, when a teacher grumbles because a child is inattentive, we must ask what exactly the teacher has in mind, and more particularly how the child's inattentiveness is exhibited. Does he seem to be attending to nothing whatever, or is it rather that he is attending to the wrong things ? The former is more characteristic of the dull ; the latter of the merely backward. But the latter is always the commoner fault, and strictly should be called not inattention but mis-attention. It is not that the child is thinking of nothing at all, but that his thoughts have got shunted into a siding.

A roving mind is by no means rare even among the intelligent—those alert and versatile youngsters, for example, who promise so much more than they fulfil, and, in spite of nimble wits, neither do the work nor yet make the progress of which they are really capable. Such a child seems always wool-gathering, as we say. He ought to be listening to the teacher's explanation of vulgar fractions and following the figures on the blackboard ; instead, 'his eyes are with his mind, and that is far away'—watching the sparrows outside, whose courtship can be spied through the playground window, or wondering if his mother will let him go to the new thriller at the pictures after tea. At its worst this kind of non-attention is to be seen in the habitual day-dreamer. The day-dreamer often passes as a dunce ; but in reality he is suffering not so much from an intellectual as from an emotional disturbance. It is a

defect of character rather than of intelligence ; and must be treated as such.[1]

These things are easier to observe than to measure ; and, in spite of constant requests for a 'good psychological test of attention,' it is extremely hard to recommend any method which will be at once helpful to the teacher and reliable in its results. On the other hand, to the trained psychologist at the clinic, dealing with a child he has never seen before, some of the recognized tests may at times be most illuminating. Those usually described as tests of attention in psychological manuals relate for the most part to one or other of its two main aspects : its scope and its duration.

Tests for the scope of attention measure the extent of the child's powers of simultaneous apprehension. How many things can he attend to at once ? Or, more accurately speaking, how many things can he grasp together and organize into a systematic unity ? The simplest material for this purpose consists of black dots on a white background. Lantern-slides may be prepared showing four, five, six, or more dots, arranged irregularly ; and, by means of a photographic shutter, each set of dots can be flashed on a screen in front of the class : after every exposure the children are told to put down on paper the correct number of dots, arranged as they were upon the slide. Big differences are always found. One child can observe no more than five or six dots at once, and then only when they are arranged in some simple scheme, like the pips on a die or a domino. Another may be able to reproduce a dozen dots, however irregularly the pattern be composed. More complex material may be obtained by using letters or figures. The same wide differences will be observed. When a row of letters or a set of figures is thrown upon the sheet, some will be able to write down only four or five ; others as many as nine or ten. If the letters form words, or the words form sentences, a much larger number of letters will be correctly reproduced. It is on record that in a German laboratory one student was

[1] See G. H. Green, *Psychanalysis in the Classroom* (1921), especially Chapter II, and *The Daydream* (1923).

able to grasp, after a flash lasting one-fiftieth of a second only, long words or sentences like: 'Aufmerksamkeitsschwankung' (25 letters) or 'Eine Tochter muss ihrem Vater gehorchen' (34 letters).[1]

To test the children individually instead of together in class, a different mode of presentation may be used. The letters, words, or patterns of spots can be printed on white cards (ladies' ivory visiting cards are convenient to handle and deal): the child is then required to deal the cards, as quickly as he can, calling out the number of dots, or whatever is printed on each card. The speed with which the spot-cards are dealt will obviously depend on the child's power to grasp each particular group of dots as forming a pattern, or system of patterns, indicating a definite number. Thus the child whose scope of attention is always limited to one item only, and who is unfamiliar with the conventional arrangements used on dominoes and playing cards, would have to stop and count each single dot.[2]

At a higher level this apperceptive power that attention confers of holding together in the mind a wide and complex scheme of component units is indispensable for all the higher intellectual processes of the senior classroom. It is impossible for the young reader to combine letters into syllables, syllables into words, and words into sentences, and to read out a consecutive passage of prose intelligently, unless he can do this. In arithmetic the same process is equally essential. Only by an effort of attention, clearly grasping composite wholes, can the child analyse out the

[1] In the laboratory these experiments are performed by means of a special appliance known as the tachistoscope, a controllable exposure apparatus which exhibits visible material for a fraction of a second only, *i.e.* with what the photographer would call an instantaneous exposure. I have described a convenient spot-pattern test, carried out with a portable tachistoscope, in my early series of experiments on intelligence at Oxford (*Brit. Journ. Psychol.*, 1909, *loc. cit. sup.*, pp. 150 *et seq.*). The test has been added to Whipple's collection in the second edition of his *Manual* (Vol. II, pp. 290–6, Test 25A).

[2] For fuller details see my article on 'Experimental Tests of Higher Mental Processes,' *Journ. Exp. Ped.*, I, 1911, pp. 93 *et seq.* As I there pointed out, such tests often reveal a marked difference between children with analytic and synthetic (or intuitive) types of mind—a difference of some importance for teaching.

details of a given problem, and re-combine those details systematically to yield the solution.

I have used this test with practically every child in the normal and backward groups. For the most part, their performances in it showed a close correlation with their general intelligence. The dull did poorly, but, as a rule, no worse than their poor intelligence would suggest. Hence, among those who were dull and backward generally I found hardly any clear instances of a specific deficiency, disclosed by this test. In two or three of the children who were backward primarily in arithmetic—young pupils in every case—difficulties with the spot-pattern seemed connected with their weak grasp of number. Difficulties with printed material were found among those who were backward primarily in reading; and here the results were exceedingly helpful in indicating the probable source of the defect in individual cases. But, for the rest, the test proved mainly valuable as measuring, so far as any one simple test can measure it, and more directly than the usual tests of intellectual capacity, the child's power of mental organization, of apperception or 'noetic synthesis,' as it has been called. No ability, or aspect of ability, is more essential for school work.

The correlation of this test with general intelligence is quite high, averaging among normal children of the same age ·63 and among the backward ·71. Alike in the backward and in the normal groups this test showed a remarkably high correlation with chronological age; and, when the influence of mental age, that is, of general intelligence, is eliminated, the partial correlation with age rises in both cases to approximately 1·00. This, if it could be substantiated, would be a most informative result. It would mean that this aspect of attention does not involve any specialized capacity, but depends solely on the level of general development. The scope of attention is, indeed, very greatly affected by differences in intelligence. But, when these are allowed for, its steady improvement appears to be the direct expression of mental growth. Yet, even apart from this experimental confirmation, and simply on grounds of general observation and theory, I should be

tempted to propound the view that the chief effect of increasing age or maturity upon the developing mind is progressively to widen and extend its span of apprehension.[1]

To measure the duration of attention a different procedure has to be employed. To the teacher, the duration of a child's attention will seem much more relevant than its breadth or scope. As we have already observed, inability to attend continuously stands out as one of the most obtrusive characteristics of the dull and backward pupil. His interest may be caught for a moment, but it rambles off again. His thoughts may be called back to his work; but they rest there only for a second or two, and possess no staying-power of their own. Usually the teacher reports that the child 'cannot concentrate,' by which he means that the child cannot concentrate for long: he lacks the gift of sustained application.

It is a drawback of most of the familiar tests of intelligence that they so seldom make any demand on this particular capacity. Scales, for example, like those of Binet and Simon consist of short sharp puzzles and problems, which need but a moment's reflection; and each question, as it succeeds the last, is of itself a sufficient stimulus to recall and arrest for another instant the fluctuating attention of the flighty child. With tests such as these, inattentiveness is noticeable only in its grossest form—as in the young defective, who merely plays with the apparatus instead of attempting the task required, or starts an irrelevant strain of chatter, and then suddenly scrambles off to the window, deaf to all the examiner's coaxing. The power to keep the mind focused on one thing for a lengthy spell is never called into action by the tests themselves.

For older children the task that yields the most effective measurement of this ability consists in marking irregular dots at a high speed for a long period. In experiments for research purposes Professor McDougall's dotting machine is commonly employed. On a long paper-tape a row of small red dots are printed, not in a line, but in an un-

[1] A similar conclusion seemed deducible from an analysis of the results of reasoning tests; see 'The Development of Reasoning in School Children.' *Journ. Exp. Ped.*, V, 1919, p. 127.

predictable zigzag order. The tape passes at a regulated rate beneath a small slot in a horizontal screen. The child has to watch the dots as they move by, and tap each one with his pencil. He must thus keep aiming afresh, and that with great rapidity. To do this for ten minutes, and never miss a dot, exacts a strong effort of continuous concentration. For rough purposes the machine may be dispensed with, and the child required to dot the paper-tape as it lies before him, pinned firmly down on a table.[1]

For younger children, and for group tests generally, what is called the cancellation of letters is the device most widely used.[2] The child is given a sheet of paper covered with rows of letters arranged in irregular order. He has to strike out every *A*, or every *E* and *R*, upon the page. The number erased in a given time (with an allowance subtracted for letters missed) is taken as the measure of his general performance. If the numbers erased during each successive minute are counted, a curve can be plotted, showing where attention has fluctuated, strayed, or declined.

In tests such as these, it is peculiarly illuminating to introduce distractions—for example, to read an interesting story to the child, or to require him to count or add aloud, while he continues at his task. His ability to resist distraction, and to avoid confusion and interference, may be taken as indicating his power of application. Tests of this kind afford convenient ways for provoking and watching the processes of attention ; but the quantitative results are highly unreliable. The figures in the table are based upon a weighted average of these two tests [3] carried out in accordance with the usual procedure : but it is distinctly arbitrary to regard them as giving a measure of duration of attention ; and I insert them only for the sake of com-

[1] This test was first used at Professor McDougall's suggestion for testing the intelligence of children in my early experiments at Oxford (*Brit. Journ. Psychol., loc. cit. sup.*, pp. 153–7). The correlations with intelligence are high, and range between ·6 and ·8 ; the cancellation test described below gave much lower correlations with intelligence, namely, ·24.

[2] Whipple, *loc. cit.*, Test 26.

[3] With many of the younger the dotting test, and with many of the older the cancellation test, was not employed : and even so not all the children were tested.

pleteness. As my investigation progressed, I found that far more was learnt without an *ad hoc* test by observing the child during the whole process of examination, and checking such observations by the teachers' reports. Further, attention varies so much according to the nature of the task and the child's interest in it, that it is always very dubious to diagnose any one individual as suffering from a defect of attention as such. So far as it was possible to single out such cases, the child with an unstable attention appeared nearly always to be a child with an unstable temperament.

Attention, indeed, as envisaged by tests of this type is largely a matter of what is loosely called will. To pin oneself down for long periods together to a prescribed monotonous task is not so much an intellectual feat: it is a feat of character. The bright intelligent youngster, condemned to mechanical exercises in the classroom, is often the most inattentive of all. This has a definite corollary for school practice. Lapses of attention are not to be regarded as incurable symptoms of intellectual feebleness, nor yet to be punished as though they were deliberate moral faults: they must be viewed as manifestations of a lack of emotional stability or of a lack of emotional interest. They are best treated by means of a graduated training. The commonest cause of inattention is sheer boredom. Accordingly, begin by giving the child tasks that will appeal irresistibly to his natural interests, so that, at first, the exertion imposed is a minimum; then, by steadily increasing the tax upon his self-command, advancing always by easy steps and stages, something like a habit of voluntary attention may in the end be established. If, on the other hand, we try nailing the child's thoughts to things that have no attraction and are perhaps too tough for his unaided powers, he will seek an escape from the pressure and the strain by renouncing all effort from the very start; and thus a habit of inattention may be implanted instead.

CHAPTER XIV

INTELLECTUAL FACTORS

C. *Special Disabilities: Associative*

Association.—So far we have considered only the basic activities of the mind—sensation, perception, and attention to what is sensed or perceived. The higher mental processes may here be treated as resting upon these, and as working through the association of ideas.[1] For practical purposes it is sufficient to distinguish two main forms of association—mechanical and logical.

By mechanical associations I mean those of which the child himself is not immediately aware. In such a case the associations govern conscious processes, but do not themselves rise into consciousness. They are not apprehended as manifest links between separate ideas : we may permissibly think of or picture them as nerve-paths within the brain, leading from one cell-group to another. Such associations are largely accidental, and often peculiar to each person, derived in the main from his own individual experience. They thus correspond to the traditional account of associations as formed by ' contiguity in time and space.'

By logical associations I understand those that are consciously perceived. They depend not so much upon past experience as upon rational analysis—upon an intensive

[1] What I have said in the preceding chapter about the importance of mental synthesis will, I trust, convince the academic psychologist that I fully recognize the inadequacy of the associationist treatment for purposes of psychological theory. I would go further, and urge that the facts and processes emphasized by the critics of associationism—particularly by the so-called *Gestalt* school—have a manifold bearing on education which offers a rich field for future research. Nevertheless, in a volume such as this, which merely seeks in an introductory way to summarize practical methods and practical results for the teacher working in the classroom, some degree of simplification is perhaps permissible.

insight whereby we discover or 'educe' (as the phrase goes) relations of similarity, contrast, sequence, space, cause, and the rest.[1] For brevity associations of the former type may be called associations simply, and the latter relations.

Broadly speaking, we may say that the less intelligent mind relies mainly on mechanical associations, and that the more intelligent depends largely on logical relations. This difference between the bright and the dull is, as we have seen, exploited by many of the commoner group tests of intelligence. Tests of 'controlled association,' as they are called—finding opposites, similarities, analogies, and the like—are really tests of the child's power to perceive and utilize relations of the kind described.

I shall consider the processes of ordinary or mechanical association first of all. These are best brought to light by what are known as tests of 'free' or 'uncontrolled' association.[2] Such tests are of extraordinary interest for the glimpses they afford into the workings of the individual mind. As is generally known, they have been largely used during recent years by psycho-analysts for exploring unconscious thoughts and motives.

There are two alternative procedures, both used by Binet in his studies of normal and defective children[3]: the one may be called the continuous, the other the discontinuous or discrete. In the former the child is asked to say any words he likes as fast as he can. They must all be different words, and they must not make sentences. Usually the examiner starts the child with some pregnant word or topic—such as 'street,' 'play,' 'school'; and the child has to continue for three minutes, or until he has

[1] See Spearman, *The Nature of Intelligence and the Principles of Cognition*, 1923.

[2] Strictly they should be called tests of free or uncontrolled *reproduction*: for the child is not required to make a new association at the moment of the testing; his associations are already made, and free reproduction is allowed in order to see what is the nature of the pre-existing associations thus readily brought to light.

[3] Cf. esp. *The Intelligence of the Feebleminded*, Chap. VI, and *L'Étude expérimentale de l'intelligence*, Chaps. II to IV.

given a hundred.[1] In the second method, the experimenter uses a list of a hundred words, prepared beforehand, which he calls out one by one ; and the child is told to reply to each with the first word that comes into his mind. In either case the child's speed is usually timed with a stop-watch.[2] (Cf. Table XXV, A and B, pp. 489–90.)

As a rule, the associations of the dull child are slower than those of the intelligent. With the continuous method a normal child of the age of 11 will give well over sixty words in three minutes (Binet's own norm) and about a hundred in five minutes. The rate diminishes considerably as the replies are given : twenty words or more are usually reeled off pat within the first half minute ; the rest filter through more and more sparsely while the second-hand of the watch goes round. With the discontinuous method, the average time for a single reply is, at this age, two seconds or a fraction more. With both methods, according to my own results, dull children are in general about twice as slow as normal children of the same chronological age. In the continuous method the speed largely depends on whether the child has happened to strike some fertile stream of thought. But no test so impressively displays the dullard's mental poverty and inertness—the paucity of his ideas and the sluggish rate

[1] Whipple, *loc. cit.*, Test 33. To ask for a hundred words, and take the time of the whole series, is the procedure recommended by Whipple. It is suitable for older children and adults. With younger children in the schoolroom I prefer Binet's original plan : first, because it does not require the experimenter or teacher always to carry a stop-watch about with him ; and, secondly, because the younger and duller children may take ten or fifteen minutes to think of a hundred different words, and some may never get so far.

[2] For methods, results, and lists of words, see Jung, *Studies in Word Association*, and Kent and Rosanoff, 'A Study of Association in Insanity,' *Am. Journ. Insanity*, LXVII, i, pp. 37–96, and ii, pp. 317–96. Neither of the lists of words employed by these investigators is very well fitted for use with children : with the aid of Mr. R. C. Moore (to whom I am indebted for a standardization of the time and commoner replies) I endeavoured some time ago to compile a more appropriate and effective set. This list, with slight modifications, has been used with some success at various child guidance clinics and was also adopted in this research. A revised version of it will be found in an appendix to *The Subnormal Mind* (2nd ed., 1937, pp. 362 *et seq.*).

at which he summons them up. In the discontinuous method the differences in rate vary too much with each particular stimulus-word for the total times to show any high correlation with intelligence: often the most intelligent child is confronted with so many alternatives that he stops to pick and choose. With both forms of the test, the pauses are as eloquent as the replies. Usually, as a little psycho-analytic exploration will quickly show, a sudden delay or blockage may be taken to indicate a passing emotional disturbance: the word just heard may strike some hidden chord; or some half-forgotten memory may spring to life, and for the moment put out of action the whole play of the child's thoughts.

TABLE XXV. TESTS OF ASSOCIATION

A. Discontinuous Method

STIMULUS-WORD.	RESPONSE.	
	1. Backward boy, aged $11\frac{8}{12}$ M.R. 77.	2. Normal boy, aged $11\frac{7}{12}$ M.R. 101.
head	your head	tail
green	you eat greens	colour
water	drink	sea
table	eating	chair
ink	drinking	black
black	blacking	white
woman	old woman	man
hungry	eating	thirsty
long	way[1]	length
ship	to sail in	schooner
deep	hole	shallow
girl	dress	boy
needle	to sew with	cotton
bake	in the oven	bread
wet	when it's a wet day	dry
butter	butterfly	melt
match	cricket-match	fire
dead	head	alive
pill	ill	medicine
cold	old	hot
stomach	ache	chest

[1] 'It's a long way to Tipperary'—a song constantly on this boy's lips—was responsible for the connexion.

B. Continuous Method[1]

1. Backward boy, aged $13\frac{3}{12}$, M.R. 78.

desk, pen, pencil, paper, newspaper, Star, blackboard, chalk, teacher, Mrs. Brown, head, feet, desk, ink, finger, hand, arm, body, coat, cloak-room, stairs, playground, ball, football.

(24 words ; 9 themes—chiefly suggested by the room and building in which the test was carried out ; 2·7 words per theme.)

2. Normal boy, aged $13\frac{2}{12}$, M.R. 109.

desk, table, chair, bed, furniture, sofa, couch, cupboard, sideboard, stool, piano, gramophone, loud-speaker, wireless, waves, ether, electricity, magnetism, North Pole, South Pole, ocean, sea, shore, rocks, cliffs, mountains, forest, trees, shrubs, bushes, plants, flowers, fruit, vegetable, potato, carrot, turnip, beetroot, cabbage, cauliflower, lettuce, green-grocer, shop, butcher, baker, confectioner, stationer, draper, barber, bank, money, cheque, note, pound, shilling, half-crown, sixpence, penny, halfpenny, farthing, copper, brass, iron, steel, metal, lead, tin, gold, silver, ring, jeweller, diamond, ruby, emerald, bracelet, brooch, ear-ring, pearl.

(78 words ; 8 themes ; 9·8 words per theme.)

The words given by the children are always full of significance. They afford a vivid insight into the interests and the mental contents of the individual boy or girl. The dull are singularly limited in the type of words they offer : for the most part, their replies consist of names of things actually visible in the room, of clothes or parts of the person, and of familiar objects seen daily in the school, in the street, at home, or elsewhere. Responses of this commonplace kind are numerous enough with the intelligent ; but every now and then they touch upon ideas which are more remote and original, and evince a far richer vocabulary : with rare exceptions, the brighter children alone give abstract words.

The intelligent child not only shows wider fields of interest ; he freely changes his grammatical categories, particularly in the discontinuous form of the test : instead of restricting himself to substantives, he answers now with adjectives and now with verbs, whereas the duller children confine themselves almost exclusively to nouns. His fertility reveals itself still more in the wealth of imagery. In every way his replies are more varied, more inventive, and less obvious.[2] On the other hand, the dull, and to some

[1] Each series was given in three minutes. They are selected because both boys happen to have started with the same word.

[2] Were I discussing the supernormal rather than the subnormal, one or

extent the very young, use only concrete nouns or trite adjectives whose meaning can be easily visualized, or even answer with several descriptive words instead of one—as though implicitly interpreting each stimulus-word by some familiar, recollected context. They are very apt to give awkward and clumsy responses, which betray their inability both to grasp, promptly and precisely, the meaning of the word given to them, and to express their own meaning, neatly and succinctly, in words of their own choice. With the dullest of all, the question-words, though intelligible and familiar enough, may at times fail totally to arouse associations. In reply the child can only give some utterly irrelevant word—something perhaps of which he has recently been thinking, or something suggested by his own last answer, or—most frequently of all—the name of something in the room.

The narrow circle of ideas within which such children move is plainly illustrated by the frequency with which they 'perseverate'; over and over again they repeat the same response or type of response, and often simply echo the stimulus-word itself. Still more characteristic is the way in which they lapse into phrases or sentences instead of giving a single word: usually such phrases are meant to describe the visible appearance, locality, or purpose of whatever is denoted by the question-word: *e.g.* 'Pencil?' 'For writing'; 'Grass?' 'Green grass,' or 'It's green,' or 'What you see in the park.' Thus they exhibit a difficulty not only in associating but also in dissociating. So accustomed are they to think and talk in complete unanalysed expressions, consisting, as a rule, of stereotyped clichés, that they find it hard to isolate and deal with a single word as such. (Cf. Table XXV, A.) Thus, at every point, the simplicity of their mental processes and the emptiness of their mental life is apparent.

What is most significant of all, perhaps, is the actual form of the association itself—the logical link by which the

two slight reservations would have to be made. In particular, it should be remarked that a high proportion of far-fetched and sophisticated replies is not necessarily a sign of genius: an excessive individuality more often suggests an erratic temperament and an eccentric or egocentric mind.

question-word and the reply-word are related. The different forms of association (or, as we have learnt to call them, relations) differ greatly in the ease and frequency with which they are made or used. Of the commoner relations implied by the answers, those of contrast seem to be the easiest and the most usual: whenever the stimulus-words permit, current antitheses like 'Good?'—'Bad,' 'Man?'—'Woman,' are given very promptly by the brighter youngsters, and quite mechanically by older children of average or poor intelligence. Next to these, both with the bright and with the dull, spatial relations seem to come most easily, especially with stimulus-words of a concrete but miscellaneous kind: as a rule, particularly among the dull, they are based more upon habitual juxtapositions, or on a mental picture of things seen together, than upon an explicit perception of the relations themselves. Whole-and-part relations—usually a special form of spatial connexion (as 'Table?'—'Leg')—appear almost as easy; the converse—part-and-whole relations (as 'Leg?'—'Table') —are rather harder; co-ordination ('Dog?'—'Cat') is easier than super-ordination ('Dog?'—'Animal'); and super-ordination than subordination ('Dog?'—'Terrier'). Relations of a more abstract kind seem far more elusive; and rarest of all, except among the brightest, are relations of cause and effect.

With the more intelligent, as a general rule, the relations that prompt their answers are apt to be of a more strictly logical type and rather widely varied: the words are linked more by their intrinsic meaning, and less by accidental associations, common conjunctions of everyday speech, or mere resemblance in sound. At the same time, the older and the more intellectual occasionally take the experiment so lightly that their smart replies may be of a very superficial nature; and jingles or rhymes depending on similarity of sound ('Hat?'—'Cat'), or completions of familiar words and phrases, depending on habitual motor associations ('Ink?'—'Inkstand'; 'Run?'—'Running'), though highly characteristic of the stupid child, will sometimes predominate even in the answers of the educated adult.

One very instructive feature brought out by such experi-

ments is this: with the brighter children the connections between their thoughts suggest a more systematic basis in the background, so that their numerous ideas seem better organized and more closely articulated one with another. Within their tidy minds everything is appropriately pigeon-holed and ranged—as orderly and as accessible as the contents of the labelled drawers that surround the chemist in his shop.

This is seen most clearly in the discontinuous form of the test. Other things being equal, the intelligent child nearly always evinces a closer sense of relevance. He tends, for example, with greater frequency to state the genus immediately above the given idea ('Pony ?'—'Horse'; 'Pigeon ?'—'Bird'; 'Spaniel ?'—'Dog'; 'Fly ?'—'Insect'; 'Eel ?'—'Fish'), always as if classifying each notion as precisely as he can. The less intelligent give vaguer and remoter designations—offering loose and general concepts that are much too wide: for example, to each of the stimulus-words just cited many will simply return the same reply—'Animal.' With the dullest 'Thing' is constantly forthcoming as a convenient, all-inclusive term. Nevertheless, much necessarily depends upon the familiarity of the stimulus-word itself; in reply to 'Daisy ?' the word 'Plant,' though more comprehensive, is only found among the brighter; 'Flower,' though more specific, is the word generally used by the dull. Now and then, bright children—like the dull, though far more rarely—will offer long answers of several words that seem intended as rough definitions or descriptions of the question-word; but with them the definitions and descriptions are more likely to hit on essential properties. The dull, as we have seen, seldom manage to divorce the general meaning from some particular or accidental circumstance—usually visualizing the two together as an inseparable whole (*e.g.* 'Pony ?'—'What goes with the milkman's cart'; 'Daisy ?'—'You see it in our garden').

In the continuous form of the experiment much the same difference may be discerned. Once again the dull child shows a curious lack of distinct and detailed organization among his successive ideas. In this test almost every child,

dull and bright alike, tends to give lists belonging to a number of different themes ; but the brighter stick longer to one and the same theme, managing usually to explore it more methodically ; and when they pass to a new topic, the jump is more natural and intelligent : the dull are curiously inconsequent. The following series occurs among the replies of a backward boy of twelve—' nose, mouth, ear, eye, you, me, they, he ' : here are two short themes ; and the word ' eye ' or ' I ' (the sound, of course, being the same) makes a meaningless bridge from an incomplete catalogue of parts of the face to a broken string of personal pronouns. With the dull the themes are nearly always brief and hackneyed, composed most frequently of crude enumerations of concrete and visible objects ; and between their various themes the transitions are abrupt, erratic, and not a little baffling, the child's mind darting off at an unexpected tangent. At times there are almost as many themes as words, as if merely to name an idea was to exhaust its significance. On the other hand, with the more intelligent the same topic may be sustained through fifteen or twenty words ; even then the child still keeps labouring to extract the last ounce of meaning out of it before he will leave it for another. All through, the words in his series are more coherently and logically grouped together, and each series follows the last in a far more rational sequence. (See Table XXV, B.)

The mental peculiarities thus disclosed are full of significance for the educator, and have a direct and practical bearing on the work of the classroom. It is often unexpectedly enlightening to discover in this simple way how narrowly circumscribed are the interests, thoughts, and fancies of some particular child, and to see how largely he is confined to blind, mechanical associations as he attempts to relate and link together the various items with which he has to deal. On the other hand, where a child is merely backward in school knowledge, but sharp in natural capacity, it may come as a startling surprise to his teacher to learn, by means of such a test, what a store of general information the child possesses, what an extensive vocabulary he has at his command, and, above all, how well his ideas are con-

nected up and classified; such a child may prove astonishingly quick at assimilating new knowledge, provided that knowledge is presented to him with the facts systematically arranged, simply because his mind already tends to work in systems. Differences in this respect affect intellectual work at every point: the bright child is an organizer, the dull child a drudge. Systematization helps the bright, but seems abstract and bewildering to the dullard: the dullard advances best by sheer mechanical memorization—drill, exercise, and practice, all leading to the slow formation of blind habits—a procedure which merely bores the more intelligent. The teacher should consider how these alternative principles apply to each particular subject—to reading, spelling, arithmetic, and the rest; and should observe that even with the backward both methods may have their place: the first will be appropriate to the teaching of those who are educationally backward only but of normal intelligence, while the second alone will yield results in dealing with the genuinely dull.

Memory.—The foregoing tests are concerned with old associations that the child has already acquired. It is equally essential to test his power of acquiring new associations. How quickly can he form them, and how long does he retain them once they have been formed?

The processes that call for investigation here are usually summed up under the general name of memory. In the child who fails to make progress in spite of good intelligence, the mental function—or group of functions—that is most frequently defective is that of memory. The reason is plain. In spite of modern reforms, our traditional scheme of school instruction is still largely based on memorization. We speak of the child as learning to read, learning to spell, learning his multiplication table, learning his lessons generally; and by learning the teacher is apt to understand a sort of mechanical rote-work that consists mainly of regular practice and reiterated drill.

Whether or not in the ordinary classroom this aspect of the total process is over-driven and over-stressed, there can be little question that memory must still provide the essential basis for all school knowledge. From the very outset,

the first rudiments of speaking, reading, or computing depend on the power to form and to retain purely mechanical associations between arbitrary and abstract symbols, like figures, letters, or words, and their respective meanings; and, at every stage of the course, a child who forgets on the morrow all that he learnt the day before will never move onward.

Memory, however, is of different kinds; and may be tested in several ways. Of the numerous tests of learning-capacity the simplest and most suggestive for practical purposes is the substitution test, as it is commonly termed. This calls into play, with uniform and measurable material, many of the mental activities that are of crucial importance for school work. Its object is to test the rate at which arbitrary associations can be formed by dint of sheer repetition. On a sheet of paper are printed rows of small geometrical symbols (squares, angles, triangles, circles, semi-circles, and the like): usually nine kinds are repeated in irregular order. At the head of the sheet stands a key, showing the nine symbols set out in a row with the figures 1 to 9 printed one within each symbol. The child has then to mark each of the symbols on the sheet with the appropriate figure as indicated by the key. At first he is obliged to keep referring to it; but, sooner or later, according to his aptitude, the task becomes automatic. The number of figures correctly inserted within a given time-limit (usually five minutes) is taken as a measure of the child's speed of learning.[1]

The exercise can be conveniently set as a group test, and often brings to light those children who in the ordinary work of the classroom have difficulty in grasping and fixing connexions between verbal or numerical symbols and their conventional names or meanings. If the test be subdivided into half-minute sections, a curve of work can be constructed to show the changes of speed. Such a curve is often highly distinctive of the individual; and it is curious to note how one child will make most progress during the earlier portion of the task, and another during the later. If the test is applied to the children singly, and each child's pro-

[1] Whipple, Test 37.

cedure observed and perhaps discussed with him afterwards, instructive sidelights may be obtained on the way in which he sets about a task of simple memorization. Some, for example, seem to take a mental photograph of the symbols and the corresponding figures in purely visual terms ; others learn the correspondences by saying over and over to themselves the names of the figures and sometimes of the symbols too ; others appear to develop, progressively and almost unconsciously, an automatic habit or movement-tendency to write such and such a figure when they see such and such a symbol. In cases like these the child's spontaneous procedure may often indicate the manner in which he works best ; occasionally it may reveal an inefficient mode of working, and the needful correction becomes obvious.

In the test I have just described the material is ostensibly visual. In others it is verbal. Verbal tests of memory are very numerous ; and further distinctions may be usefully introduced. We may distinguish, first of all, between (1) *mechanical* and (2) *logical* memory, and, secondly, between (*a*) *short-distance* or 'immediate' and (*b*) *long-distance* or 'delayed' memory.

Mechanical memory is sometimes called rote-memory or habit-memory : it is the power to retain connexions between a series of discrete impressions, preserving the order in which they were originally given, but unaided by any logical significance belonging to the whole. It is the memory of the parrot, who attaches no sense to what he reproduces. Logical memory is memory which rests on meaning : it is memory for related ideas, for the intelligible connexions of a sensibly constructed whole. The two kinds depend on the different forms of association that I have already distinguished—on mechanical association and on logical association respectively.

The substitution test was essentially a test of mechanical memory, but in visual form. To test the same type of memory with verbal material we must rule out the influence of meaning and of rational connexion which familiar words inevitably convey. The usual method is to prepare a list of disconnected nonsense-words—'jeb, wok, bim, nav,' or the like ; and to make the child repeat the list again and

again until he can just say it by heart.[1] The number of repetitions measures inversely the speed of learning. Or the test may be applied to the whole class, and a limited time allowed. In this case, the learner is generally required to read over the list with a well-marked trochaic rhythm, thus combining the words in pairs. The examiner then calls out the first word of each pair—the accented word, and the child writes down the unaccented word that immediately succeeded it. The number of words correctly given is taken as the measure of the child's retentiveness.

To test logical memory the same general procedure may be adopted. But the words will now be intelligible monosyllables—concrete nouns whose meaning is well known to every child; and each will be linked to the next by some transparent relation, thus: 'Grass, green, blue, sky, sun, moon,' etc. As before, the time taken to learn the whole list by heart measures the child's speed of learning; or, if the exercise is given in class and the same time imposed upon all, then the first member of each pair may be called out by the examiner and the children will again be required to supply the word that came next. With intelligible material such as this fewer repetitions will suffice.

Where the links that bind the parts together are derived, not only from the relations between successive pairs of words, but also from the meaning conveyed by the entire passage envisaged as a consecutive whole, repetition is even less essential. Hence a favourite test for logical memory consists in reading to the child once only a simple and interesting story, and then asking him to reproduce the gist of it. By preference one of the stock stories should be used, for which results have already been standardized.[2] The number of ideas correctly reproduced provides the best measurement.

With both meaningless and logical material the reproduc-

[1] With young and backward pupils, unless special precautions are taken, nonsense-words are apt to introduce irrelevant difficulties. Consequently it is often better to employ a list of disconnected nouns. The general procedure that I have suggested, together with lists of suitable words, will be found concisely described in Whipple, *loc. cit.*, p. 371 (Test 38).

[2] See Whipple, Test 39.

tion may be either 'immediate' or 'delayed.' In 'immediate' reproduction, the child is required to repeat forthwith what he has just heard or learnt. In 'delayed' reproduction a definite time-interval is interposed—a day, a week, or a month. The one depends upon what I have called short-distance memory; the other upon long-distance memory.

Obviously short-distance memory will be by far the easier to test. The memory-tests inserted in the Binet-Simon scale illustrate the simplest plan. The examiner calls out three, four, five, or more figures, as if he was giving a telephone number; and the child has to say them after the examiner. The average child can repeat two numbers at the age of 3; three numbers at the age of 4; four numbers at the age of 5; five numbers at the age of 6; six numbers at the age of 8 or 9; seven numbers at the age of 11 or 12; while eight numbers are barely within the capacity of the average adult. This forms a test of short-distance *mechanical* memory. In addition to numbers, Binet also prescribes sentences of increasing length: six syllables for the age of 4; ten for the age of 5; sixteen for the age of 6; and so on. These provide a test of short-distance *logical* memory. If, therefore, a child passes all the other tests for a mental age of 8, but cannot repeat five numbers nor yet a sentence of sixteen syllables, his short-distance memory is apparently defective, for both are tests that should be passed by a child of 6.

According to the principle enunciated above, whenever the development of a child's memory appears retarded by 15 per cent. or more below the level of his intelligence, I consider him to be suffering from a specific defect of memory. The figures for short-distance memory given in the table above (Table XXIII, p. 466) are based on individual tests, with nonsense syllables and with a story respectively. The measurements, however, obtained for 'logical memory' from the story-test correlate closely with those for general intelligence: the coefficients average ·68. Hence in considering specific disabilities (Table XXIV, p. 468) I have included only the results for 'mechanical memory' obtained with nonsense syllables: here the correlations with intelligence were lower—averaging only ·41.

Judged by this test, about 8 per cent. of the backward children seemed to be specifically defective in short-distance memory.

Plainly, a pupil who cannot hold in mind for a few brief seconds the figures, the sentences, or the instructions he has just heard, is bound to be severely penalized in all his lessons. But for steady progress in school it is of little use to remember a thing for a minute or two only: what is learnt must be retained, not merely for hours or days, but all through the term and even for ensuing years. A child whose long-distance memory is defective can build up no solid structure of permanent knowledge, for as fast as he turns from laying the groundwork to piling fresh acquirements on top of it, the older foundations begin to crumble, and ultimately slip from sight. In dealing, therefore, with the educationally backward, next to intelligence long-distance memory is by far the most important capacity to investigate.

Unfortunately, however, tests for long-distance memory are from their very nature cumbersome and slow. Often the results of the short-distance tests may awaken a helpful suspicion. I find, as a general rule, that, if a child's short-distance memory is poor, his long-distance memory is weak as well. That is but natural; when he cannot remember a series of numbers for a few seconds he is not likely to remember them for several weeks, even with extra repetition at the outset. The converse does not hold. A child's memory may fail to last over long intervals of time, but he may manage quite well in a short-distance test which demands nothing but an immediate echo on the spot.

A little light may often be gained from other tests in the original Binet scale. As the standardization shows, most children who have been regularly to school know the days of the week by the age of six, and the months of the year by the age of nine. Now the ability to say such lists by heart, whenever they are called for, manifestly depends on long-distance retention. Hence an undue failure in such tests may often indicate a poor long-distance memory. Similarly, though the age of learning them varies rather more widely, the knowledge of the addition or multiplication tables, acquired through the same capacity, may also furnish a

rough criterion. Here, therefore, the examiner has several simple clues which may incidentally serve to reveal a special weakness in this direction.

To test this function more exactly an elaborate technique is required. The best method is the following. A list of disconnected words is first repeated, as before, over and over again by the child, until he just knows it by heart; after a specified interval—say a week or more (with my own tests, a fortnight)—the examiner returns; and the child is set to re-learn the same list. Naturally he will now re-learn it with far fewer repetitions than at first. The percentage of repetitions so saved may be taken as measuring the strength of his mechanical long-distance memory.

To test long-distance memory for intelligible or logical material a story is read over to the child once only. He is required to re-tell it immediately, and again after a fortnight's interval. The number of items remembered on each occasion may be taken as a measure of his short-distance and long-distance memory respectively. All the children in my groups were tested individually; and their reproductions were given by word of mouth, since, with backward children, writing introduces a disturbing element. So far as the results can be trusted, a specific defect in long-distance mechanical memory seemed to contribute to the children's backwardness in 14 per cent. of the cases. All who showed a disability in the short-distance test showed an analogous disability in the long-distance test: but in the latter the disabilities were far more numerous and usually more pronounced. The 'logical' form of the test, however, gave much the same results as the ordinary tests of intelligence: the correlation was ·71. Consequently, this form was used only in a few special cases; and hence, for long-distance as for short-distance 'logical' memory, no results are given in the table for specific disabilities (Table XXIV).

With the dull child mechanical memory is not, as a rule, very much below the low level of his general intelligence; not infrequently, indeed, it is actually above it. But in the merely backward, in whom intelligence is more or less normal, a definite inferiority in memory (not always serious enough to amount to a 'specific disability' as defined above)

proves exceedingly common. Again and again the findings of my tests were confirmed by the remarks of the teacher or parent. 'He is a bright enough lad in most things, but he can't seem to learn.' 'He works hard; understands what he is told; but has a brain like a sieve.' 'He's clever about the house: but if ever I send him on an errand or a message he always forgets half he's told. His dad was just the same.' These are samples of the type of comment that recurs perpetually in my reports.

At times, however, when the teacher declares that the child has no memory, the psychologist with his laboratory tests finds that the child's memory is excellent. Such discrepancies are not numerous, but they are exceedingly instructive. At first sight they seem to bear out the contention of those who claim that every memory is specific, and that learning depends, not so much on any general power to learn, but rather on the particular nature of the subject-matter to be learnt. Yet when the cases are studied more closely this explanation has to be modified. Usually it turns out that the child's capacity for retention, as measured by the tests, was correctly assessed. What is at fault is attention rather than retention. And the lack of attention is commonly attributable, as we have already seen, to two main sources: either to a lack of general stability of temperament or to a lack of interest in the subject.

To the casual observer in the classroom the unstable child very often appears afflicted with a hopeless memory. But, where concrete events are concerned, owing to his intense emotional excitability, he may recollect what appeals to his own fancy better than anybody else: so that the parent can easily cite instances to confute the teacher's low opinion. As a rule, however, his interest flowers and fades in an instant; and, where he has to deal with unexciting, abstract facts and figures, his natural volatility keeps him from applying his mind to them for more than a few minutes together. Here, therefore, what masquerades as a memory-defect is really a defect of character.

Just as memory depends upon attention, so, we have seen, attention depends upon interest. Hence a great unevenness in memory-power often reflects the divergences

in the child's own natural interests. How many lads find no trouble whatever in recollecting cricket scores or the names of His Majesty's ships, but seem devoid of memory altogether when it comes to the multiplication table! They resemble that mysterious stranger at the Professor's breakfast table who was christened by Holmes the Scarabee. At every meal he sat absorbed and silent, and was supposed to be dull-witted, until one morning somebody mentioned 'beetles.' In a flash he awoke to the world around him, and discovered unsuspected wells of knowledge and sagacity. Then, as the conversation reverted to the housing problem, the specialist relapsed into his customary torpor. Not a few backward children are of this type—scarabees, impatient of spelling, bored by sums, and blandly indifferent to the dry topics of their school-books. Yet try handwork or dramatic self-expression; then the dull oyster shows its pearls, and the most unresponsive reflects some glint of wisdom: they will explain, from first-hand knowledge, how the school play was staged at the cinema, how the costumes and properties can be made, how the scenery should be constructed and the wings set up; and the most forgetful will throw their hearts into the business, and memorize long dialogues with accuracy and ease.

Habit-formation.—It is convenient to distinguish what may be called habit-formation from memory in the stricter sense. It constitutes the essential process in the acquisition of what are termed 'skills.' Habit, like memory, is a result of learning; and, like memory, it depends largely on associations of a more or less mechanical type. But habit is motor, while memory is ideational. Memory might be loosely described as depending on associations between ideas or sensory presentations, and habit as depending on associations between movements, or between specific muscular contractions and the sensory cues that prompt and guide them. With the dull and the mentally defective habit plays a far wider part than memory; and yet its function is far more often overlooked.

Numerous tests of habit-formation have been invented by the psychologist. Of these the exercise that proves most successful with school children is mirror-drawing. The

child traces a six-pointed star, watching his hand in a mirror. He goes over his task again and again, usually at the same sitting, until his speed shows no further improvement. For each trial the time is measured in seconds ; and the results may be plotted as a so-called 'curve of learning.'[1] Incidentally, it is interesting to ascertain how far the effects of such training are generalized, and how far they are confined solely to the muscles that have been specifically practised. With the mirror-test, for example, we may test the speed and skill of the left hand—first before, and then after, the right hand has been trained by repeated trials. Most of the normal children show a well-marked transference of improvement from the right hand to the left ; others, and especially the dull, show none at all.

Sometimes a test may be required which permits of a longer period of training—many weeks of daily practice instead of twenty trials lasting only half an hour. For this purpose the plan that I have found appeal most to the children, and at the same time prove most revealing to the teacher, is the daily practice of standard exercises on a typewriter. There are few pieces of apparatus that so delight the heart of the ordinary boy and girl ; and the task itself leaves a permanent record of the work done. The standardization of the test follows the usual lines.

From a single test involving only a single type of manual process, such as either of the foregoing, sweeping generalizations can scarcely be drawn. Habits are too specific. Nevertheless, to sample the child's power of acquiring skill in this way, and to study under experimental conditions his general mode of procedure, will often prove illuminating. The curves of learning[2] procured with such tasks are frequently typical of the individual's methods of work. One child will make no progress to begin with and then suddenly start steadily improving. Another will make rapid progress at the outset but fail to maintain his initial speed. Others, again, advance as it were by instalments ; they improve

[1] See Burt, *Brit. Journ. Psych.*, *loc. cit.*, pp. 145–9, and Whipple, *loc. cit.*, Test 36. My own data show a fair correlation between the results of such a test and general intelligence. Whipple, however, found no difference between dull boys and bright.

[2] Cf. Appendix II, pp. 636 *et seq.*

and then seem to stagnate—probably they are really fixing and consolidating the achievements already gained—and then presently they will make a further step forward.

Since habits are so specific, the effects of improvement in one field of work are transferred to other fields only to a very limited extent and under fairly restricted conditions. The spread of improvement from one subject to another is far smaller than most teachers suppose, and differs greatly with different children. What was observed with the mirror-test is found in nearly every experiment on habit-formation: the duller children as a rule carry over no improvement whatever, unless they are explicitly shown what points of contact the two spheres of work have in common. They may grasp a principle; they may learn a rule; but they seldom see when to apply them. Each time they have to be told afresh what method to use or which procedure is required. Nearly all their training has to be specific—expressly undertaken for the particular task in hand.

Imagery.—Different children, however, learn best by different channels: they memorize and recollect with various degrees of ease in various media. Some tend naturally to recall a thing in terms of its concrete appearance; others tend just as naturally to think of it in terms of its name or verbal description. There are thus what may be called thing-thinkers and word-thinkers respectively.

The thing-thinkers may in turn be subdivided into three main groups. The majority carry on their thinking by the aid of mental pictures, seen with their mind's inner eye. Whatever they are reading about, whatever they are learning, whatever they are trying to reproduce, their plans, their recollections, and their daydreams, all are visualized. This group includes most of the younger children, nearly all uneducated adults, and a large proportion of educated women. One of my own students may serve as a typical specimen. Her first-hand account very clearly depicts what must so often go on in the mind of the visualizing child, though he himself is generally too young to explain it.

Miss I. A., as I shall call her, has achieved an honours degree in English literature and is now training as a secondary teacher. In all the tests that I have applied

she shows an amazing visual memory for details. Although her education has been almost exclusively of a bookish type, she confesses that she still does nearly all her thinking in pictorial form. Like Grace in Aldous Huxley's story, 'what she cannot visualize, she cannot think about.' For her *A Midsummer Night's Dream*, for example, is not a series of speeches in blank verse; it is a changing scene which she mentally pictures, with a set of personages, who come and go, and gesticulate appropriately, but have no special names and utter no remarks. All is in dumb show. She sees, with the minuteness of a photograph, a fat little man, in Greek costume, with an ass's head, but cannot for the life of her recollect what he was called. Presently she seems to catch sight of him at a loom, and declares he must be 'somebody the weaver': then the word 'Bottom' appears plainly printed in an open book. In the examination room she is able to reproduce whole passages from her lecture-notes simply by conjuring up a mental facsimile of the scribbled page. But while she was preparing for her degree, her notes on the more philosophical subjects at first conveyed no meaning to her, because she 'felt they ought to bring back a voice'; and, as 'she never heard voices unless they were real,' she 'could never grasp an abstract notion unless someone was actually there to explain.' 'But nowadays I try to think of a concrete example, and that helps me to carry the fact in mind.'

Of her inner mental life she says: 'It is as though I inhabited a private cinema; the films go on for ever; but none of them are "talkies".' She believes this excessive visualization prevented her from grasping spoken explanations as a child at school, and made her the 'worst in her class at elocution and French.' 'I was always seeing things when I ought to have been listening.' And even now these vivid images are often more of a hindrance than a help. While writing letters, essays, and notes, the concrete illustrations will actually side-track her attention; and she tends to go on retailing the things she visualizes, regardless of their relevance to her original topic. Occasionally the picture of some concrete scene or object will intrude itself so solidly that she cannot get on with her thoughts or her

reading. After her brother died she complained that his face kept 'coming between me and my book, blocking out all the print.' Indeed, her distress on this occasion seemed to require the wise advice of the doctor called in to examine a murdered corpse and confronted with a frantic relative: 'Get the picture out of your mind: the picture is always the worst part of it.'[1]

Others have a special gift for hearing sounds with their mental ear. They are ear-minded rather than eye-minded. The tendency seems commoner among boys and men. I. B., for example, is a boy whose only memory of the Zoo consists, not of a recollected vision of lions and leopards in cages, nor of the singular smells of the monkey-house (which so much impressed his sister), but of the noises that the beasts made—the chatter of the apes, the yelp of the sea-lion, the screams of the parakeet. Another student, I. C., is the very reverse of Miss I. A. He can call up mentally a whole orchestrated symphony, with nothing but the score in front of him; he hears not the melody only but the various instruments sounding together—cornet, oboe, strings, and drums—each with its own characteristic timbre. Except in dreams, he has never (so he believes) had a visual image in his life. At school he discovered that, if he was to remember the things that he saw, he had there and then to draw up a verbal inventory of their chief points as he examined them. He was a deplorable speller, until he started learning all the irregular words alphabetically by rote: whether a word 'looked' right or wrong he could never say. In Euclid he got easily lost; and his sums he used to work out mechanically by rule, without in the least realizing what the problems meant. While Miss I. A.'s essays are full of fanciful imagery, I. C. seldom uses a simile or metaphor, and if he does they are apt to get curiously mixed. 'The seed of a new literature,' he writes, 'had dawned in this strange vein of poetry.' Let the visualizing reader try to picture a grain of mustard seed glowing like the early dawn within a blood-vessel, and he will understand that this student thought chiefly in verbal clichés and not at all in visible images.

[1] Dr. Ross, if I remember rightly, in J. J. Connington's *Eye in the Museum*.

Others, again, feel in imagination the movements that have to be made. For I. D. the memory of a concert 'is mainly rhythmic: I imagine myself dancing or beating time; sometimes I feel myself humming a tune in my throat. But I hear nothing; and I don't see the singer.' He says he thinks 'chiefly in terms of touch'; but it is clear that by touch he means really the feeling of movement. For example, to understand how a piece of machinery operates he finds it of little use to gaze and peer: 'I have to push and pull, or take the thing to bits.' All through, he says, whether in re-enacting the past or in planning the future, 'I seem to be fancying myself going through the motions; I never *see* myself moving about; and in fact my mind never bothers with what it simply sees or hears.'

Here, then, are three distinct modes of concrete thinking and imagination—visual, auditory, and motor.[1] Among word-thinkers the same threefold subdivision may be found. Miss I. A., as we have seen, is a visualizer for words as well as things. Before spelling a word she first wonders how it looks. When working a problem in mental arithmetic she sees the figures set down in black and white. When she plays a tune from memory there swims up before her inward eye a floating image of the score, with the stave and notes 'as distinct as if they were on paper.' Even as a child she remembered her poetry and her tables by imagining the book open before her and reading them off from the printed page. At times her visual picture fails her; and then, she says, she feels 'like the clergyman who delivered his sermons from an imaginary manuscript, and used to halt or hesitate whenever he came to an erasure, because his corrections were so confusing.'

But others—and these are far more usual—think not of the look of the words but of their sounds. Swift says in a letter to Stella: 'When I am reading a book, it seems to me to be alive and talking to me.' And yet another student

[1] Some psychologists contend that there are no true motor images, only actual movements, slight and incipient. This view has been strongly urged by the behaviourist school to explain motor imagery of a verbal type, and is now accepted as orthodox by one of the most recent American textbooks (Boring, Langfeld, and Weld, *Psychology: a Factual Textbook*, p. 347).

of mine, I. E., explains that, when he picks up a volume by a professor whose lectures he frequents, or glances at a letter written by a friend, he invariably hears, as it were from over his shoulder, the writer's own voice uttering each word with characteristic accent and inflection. The long descriptive passages in *Ivanhoe* or *Middlemarch*, he says, mean nothing to him, because he never pictures the scenes portrayed ; but he revels in the word-music of Pater or Sir Thomas Browne. Always he has been a painfully slow reader ; and he adds by way of explanation that he has to 'go at the rate the author would go if he were reading it out to me aloud.' If I. E. and a friend are reading together from the same copy, I. E. finds himself only half-way down the first page when his friend is ready to turn over the leaf. Since he has been at college, however, he has tried a new method—jumping direct from the look of the words to their sense, and has been cultivating the art of skimming.

A third group fix and focus their words chiefly through imaginary movement—movements of the lips as in muttered speech, or (more rarely) movements of the hands as in writing. Such persons think of the sounds of words, not as they would hear them, but as they would make them. One eminent psychologist, indeed, has declared that after a long spell of silent reading he generally has a sore throat.[1] With some the lip-movements are actual and visible : you may see their mouths silently working as they read over a difficult passage to themselves. I. F., for example, has this trick. If I give her a brief instruction, there is a pause while she repeats it inaudibly with her lips, and then she makes a little comprehending nod. She tells me that, when thinking out any problem in her mind, she finds it hard to carry on a train of reflection unless she is actually muttering it over. In class her mistress would often say : 'Who is mumbling ? Do stop that silly habit of moving your lips.' 'And then,' the girl adds, 'as soon as I stopped my mumbling, I stopped my thinking too.'

Most persons belonging to this group, however, can say their thoughts to themselves without any overt motion of

[1] Professor Titchener, *Lectures on the Experimental Psychology of the Thought Processes* (see especially pp. 4–36).

the mouth. They call the words up by means of a felt image (if the term 'image' can still be used)—that is, by a purely mental reproduction [1] of the muscular changes that would make them. Ask such persons to open their mouths and separate their teeth, and then to think of words containing dentals or labials, like 'pity,' 'bottle,' 'puddle': they find it extremely baffling, because for them the words are not noises they can simply listen to in their mind's ear but imaginary movements of lips, tongue, and teeth—movements which now seem negatived by the fixed position imposed upon them. They nearly all habitually employ some kind of internal speech for their thinking; and this method, though usually the most elusive, seems the most widely prevalent among educated adults.

I have taken my examples chiefly from adults—from students training in psychology, because such persons are best able to analyse and report on the inner workings of their minds. But often with a little tact it is possible to get school children, particularly older and brighter girls, to carry out the necessary self-examination; and then much the same processes and distinctions are nearly always found.

The differences are technically described as differences in mental imagery; and various expedients have been suggested for detecting individual peculiarities or preferences by means of a rapid test. But in practice, especially with children, such tests proved to be far less trustworthy than earlier psychologists hoped. In my experience the method employed by Galton—a detailed questionnaire—still remains superior to any of the more exactly standardized procedures subsequently devised: it is, however, inapplicable to the very young, to the very dull, and to those who find it hard to introspect. A set list of suitably selected questions is employed; and the child is asked whether he can picture particular things in fancy, hear particular sounds in the mind's ear, and so on. For example: 'Can you remember the look of your breakfast-table as you sat down to it this morning? Can you see all the plates and cups distinctly? Can you distinguish the different colours—the yellow of the egg, the white of the

[1] See, however, footnote 1, p. 508 above.

table-cloth, the blue-rimmed cups, and the red tomatoes ? Can you smell the coffee or the bacon ? Can you taste the jam ? Can you hear the clink of the teaspoon against the saucer ? ' It is not difficult to devise a number of little problems that can only be solved by imagery of some particular kind : for example, ' fancy yourself standing on your head, facing your bedroom window ; now stretch out in imagination your left hand ; in which direction is it pointing—towards the door, or the fireplace, or the wall opposite the window ? '

Marks may be given for correct or affirmative answers ; and some investigators require the examinee to award himself extra marks according to the degree of clearness with which he can summon up each image. The totals for vision, hearing, touch, taste, smell, and movement are then expressed as a percentage of the normal standards, and are taken as roughly signalizing in which particular direction each child is gifted or wanting. Once more, however, it is not the final marks that are of value, but rather the insight gained during the inquiry into the private scenery of the child's own mind.[1]

[1] The reader who has not applied the method may be inclined to doubt the child's powers of self-analysis. When he tries it he is usually surprised. Galton had the same experience. ' It is much easier than I had anticipated,' he writes, ' to obtain trustworthy replies to psychological questions. Many persons, especially women *and young children*, take pleasure in introspection, and try their very best to explain their mental processes ' (*loc. cit.*, my italics).

Where the problem is merely to determine to which type a given individual belongs or approximates, my own method is as follows. He is asked to imagine certain experiences, visible, audible, and so on, and to arrange these experiences in order of the vividness with which he can call them up. To determine how closely he approximates (say) to the visual type, his order is then correlated with the order furnished by a typical visualizer (or, to be more accurate, with the order given by the general visual factor that may be deduced to account for the specific correlations between the various persons tested). The more usual method is (as noted in the text) to compare the individual's marks for vividness of visual imagery with a normal standard, which is obtained by averaging the marks of all the examinees. To this there are obvious objections. It tacitly assumes that two different persons, having visual imagery that was equally vivid, would, quite independently, award themselves exactly the same mark. Actually, we assign a man to the visual type, not because his visual imagery is more vivid than that of other persons, but because it is more vivid than his own mental imagery in other

The teacher who tries the questionnaire with his pupils will be astonished to find how graphically many of them can visualize. With rare exceptions, boys and girls—particularly girls—tumble at once to the idea of 'mental pictures,' while the non-introspective adult will often demur that the phrase is no more than a figure of speech. At times a child will picture the scene suggested with a luxuriant wealth of detail that the examiner himself can never evoke. Accordingly the teacher should not omit to apply the questionnaire to his own mental processes.[1] The most remunerative result will be to discover how widely his imagery differs from that of his pupils, and where he can usefully modify his explanations and descriptions to conform to their imagery rather than his own.[2]

spheres. In an early research on mental imagery, I found that the procedure of first comparing a man's performances among themselves instead of comparing them with the performances of others gave results which were more than twice as reliable as those furnished by the usual procedure. This is, in fact, one of the instances where correlating persons gives more valid results than correlating tests. (Cf. *J. Exp. Ped.*, 1912, p. 251.)

[1] A fairly detailed version will be found in Titchener's *Experimental Psychology*, Vol. I (Qualitative), Part i (Students' Manual), pp. 198 *et seq.*

[2] I once witnessed a lesson in which a teacher was explaining to a backward class, boys of eleven to thirteen, what she called 'the geography of islands.' At the end of the lesson I asked the pupils to draw me a picture of an island. The brightest got out his coloured crayons, and drew a short stretch of yellow coast, with headlands at each end, floating apparently on a dark blue sea, the centre crowned with fan-shaped palms. The teacher thought the sketch looked more like 'a yellow cocked hat with green feathers.' The boy explained that he had read *Treasure Island*, and had tried to reproduce an illustration from his copy. The dullest of all drew two straight lines to represent a road and between them an oval street refuge with a lamp-post in the middle: this was the only mental picture which the word 'island' had evoked in his mind. The teacher, who had agreed to take part in my test, drew something that looked like a boot—or rather a series of three boots one within the other, for the outline was in triplicate: she expressed herself as dissatisfied, because, she said, she knew that Sicily 'looked like a boot", but she could not remember which way round it went. Actually she drew it, as right-handed persons nearly always draw boots, with the toe pointing to the left.

The conclusion I had come to as I listened to her lesson was confirmed by the sketches and by the teacher herself. She thought of such things almost exclusively in verbal terms. To her Sicily, and islands in general,

Without some further corroboration, however, the numerical results of the questionnaire can hardly be trusted as the basis of statistical comparisons. Some children take a greater interest in the pictures that rise before their minds, and seem quicker at detecting imagery than the rest; others—of a lively, communicative turn—are tempted to exaggerate the brilliance and the vividness of the images they call up. Hence we need some objective standard as a check. Of the more strictly quantitative methods perhaps the best is that which is sometimes known as the 'method of letter squares.' This consists in getting the child to memorize groups of letters or figures in various ways—by ear or by eye, with or without lip-movement, and then noting which of the ways helps him to remember the greatest number. The examiner may first recite a series of twelve figures; to prevent lip-movement and (so far as possible) motor imagery, the child is told to keep his tongue between his teeth: he is then asked to repeat or write down the figures. Secondly, instead of hearing the figures, the child sees them printed on a card, arranged in three rows, and is required to reproduce them as before. Thirdly, he is told to say twelve figures aloud, one by one, after the teacher; and, finally, to read them aloud from a printed card. The relative number of items remembered in these different ways is treated as indicating his predominant type of mental imagery—auditory, visual, or motor. To confirm his use of visualization, the child may be asked to assign the figures to their appropriate places on the card, taking them in a different order, calling them out by columns if he read them first of all in rows, and vice versa.

were not places to be pictured, but ideas to be talked about in abstract words. Her only representation of Sicily was an abstract diagram, which was in no way a visual image of what she had seen on a map, but in its turn was recalled by the aid of a word, namely, as something possessing a boot-like shape. Her lesson, though it consisted of accurate verbal definitions, had done nothing to summon up appropriate pictures in the minds of the children such as they could piece together from what they themselves had seen or imagined. Indeed, she confessed it had never occurred to her that children might get the meanings of concrete words in terms of images recollected from their own first-hand experience.

The visualizer can usually do this with ease; but the audile or motile has to run through the whole list again in the original sequence.[1]

Similar tests may be conducted with concrete objects or experiences instead of verbal symbols. The child may be told to listen to noises; to execute prescribed movements; to look at pictures or actual things. Then, after a suitable

[1] For precise details as to procedure and marking, see Whipple, *loc. cit.*, Test 38B. Plainly the results do not depend upon imagery alone. When we show a child the printed square of letters, we can never be quite sure whether he is not at the same time hearing the words inwardly, even if the fixture of tongue and teeth successfully prevents him from muttering them over to himself. Further, failure with the first part of the test may depend on difficulties in auditory perception as well as in auditory imagery; and failure with the second part on difficulties in visual perception as well as in visual imagery. For psychological accuracy the distinction would be important; but for practical purposes it matters less. Indeed, in actual practice and as a general rule, the child who is weak in analysis and re-synthesis through visual perception also seems weak in visual imagery, and vice versa. And in any event the differences revealed by the tests should accurately suggest which channel will help the child most both in learning generally and more particularly in learning to read.

To some extent the ambiguities in the test-results may be met by various modifications of the standard procedure. For example, I find that the results are more likely to depend upon imagery alone if the examiner employs what may be called the method of deferred reproduction (see Whipple, 'Variation (1)'). Instead of asking the child to reproduce the letters 'immediately after the exposure,' an interval of twenty seconds is interposed. During the interval the child may be kept occupied with counting. Instead of looking at letters (which almost automatically suggest their own names, *i.e.*, audito-motor imagery instead of visual) the child may be shown, one at a time, simple shapes or colours (preferably those which do not clearly suggest a definite name), and then be required after an interval to pick out, from a number of different samples, the one he has just seen.

The letter-square method can be used as a group-test, and applied to the whole class at once; but obviously the results will be less exact, since all cannot be similarly placed for seeing and hearing. For group-tests with dull children, Miss Bridie suggests using words instead of letter-squares; and instead of brief exposures she recommends teaching the spelling of the words for three minutes. Six words are to be taught first by writing them on the blackboard, and allowing the children to study them: after an hour's interval the words are to be dictated. On another occasion six other words of equal difficulty are to be spelt orally to the class. On a third occasion six words are to be copied and re-copied. In each case the time-interval before the final test is to be the same (*Special School Work*, p. 94).

A skilful teacher can get fairly trustworthy results by the following

interval, he is asked to describe what he has heard, done, or seen.[1]

For comparative inquiries I rely mainly on an extended version of Galton's questionnaire, supplemented by the memory-tests for figures and letters. So far from clearly marked types being frequent, most normal children, I find, possess imagery of a mixed and miscellaneous kind. There is, indeed, a positive and not a negative correlation between the different forms[2]: the child who has vivid imagery in one direction tends to have vivid imagery in other directions. Hence the classification given above must be regarded as a classification of tendencies rather than of types. 'Investigation fails to find any pure types; and shatters the hopes of those who believed that some day children might be divided into classes of audiles, visiles, and motiles, taught by duly selected audile, visile, or motile teachers.'[3]

Yet a large number show tendencies to use predominantly one form rather than another. In early years,[4] save for

class-test. Numbers containing four or five figures are read out to the children once or twice by the teacher, or shown to them on cards for three or four seconds. (The number of figures, repetitions, and seconds must depend on the pupils' intelligence.) After seeing or hearing each number the children are told to shut their eyes. On the first occasion those who can then see the number are asked to write it down; the others are told to leave a blank. On subsequent occasions those who can 'hear what the number sounds like,' or can 'say it to themselves,' are told to write it down, the others leaving a blank. Many children—even when the number is read out to them—will find that they can see it but not hear it; while others —even when they have seen the number on a card—find that they can hear it but cannot see it mentally. The test will, of course, have to be repeated several times; and much will depend upon the tact of the teacher in getting each child to understand what he has to do. Nevertheless, where it is impossible to examine every pupil individually, even a rough method such as this will serve in skilful hands to pick out the more extreme cases. Other methods for testing the imagery of children for practical purposes in school are described in Grace Fernald's *California Teachers' Manual of Spelling* (1918, esp. pp. 4–7).

[1] For these various methods compare Whipple, Test 38.

[2] The coefficients obtained were: visual and auditory imagery, ·27; visual and motor, ·37; auditory and motor, ·56.

[3] T. H. Pear, 'Imagery and Mentality,' *Brit. Journ. Psychol.*, XIV, 1924, p. 291.

[4] This applies primarily to children between 8 and 14. During the

a few exceptional cases, visual imagery preponderates. And, further, those showing marked deficiencies in one particular direction—non-visualizers, and especially poor audiles and children with no inner speech—seem far commoner among the backward. Psychologists no longer urge that the teacher should investigate the ideational type of every child in his class ; but I am inclined to suggest that such a study, though neither practicable nor necessary in the ordinary classroom, would nevertheless be of great assistance in working with the backward and the dull.

Of the backward children in my groups at least 55 per cent. were predominantly visualizers ; and the inherently dull in particular appeared far more dependent on mental pictures than those backward children who were of normal intelligence. Whether it would be fair to predict that the visualizer is likely to be less intellectual than the non-visualizer I should not care to say. Napoleon is reported to have declared that 'there are many who from some peculiarity of their character form a picture of everything : no matter what good qualities they may possess, such men are unfitted to be trusted with command.'[1] Some of my cases suggest that the visualizer, just because he is a visualizer, is less likely to be a verbalizer or a vocalizer : hence he often experiences special difficulties when he comes to the more abstract branches of the curriculum, because his thinking is not accustomed to clothe itself in verbal form. A psychologist who is also a vivid visualizer writes as follows : 'One of the visualizer's chief troubles when thinking is his comparative poverty in language habits. Talking to himself, either vocally or sub-vocally, may occur so seldom to the well-marked visualizer that, when it happens in moments of stress, it may even startle him.'[2]

26 per cent. among the backward were motiles, but only 9 per cent. were audiles. Indeed, the results both of

infant school and pre-school period there appears to be a marked tendency towards motor imagery ; and this remains longer with the boys than with the girls. But trustworthy evidence is difficult to secure.

[1] Hume, *Précis of Modern Tactics*, p. 15, quoted by Galton, *Inquiries into Human Faculty*, p. 78.

[2] T. H. Pear, *Remembering and Forgetting*, p. 64.

my questionnaire and of the supplementary tests seem to indicate beyond all question that, in the backward group, the form most frequently defective is auditory imagery—the images by means of which many of us remember spoken words. Certainly the thoughts of the unintellectual pupil run far less along verbal lines than those of the intellectualized teacher who instructs him. Yet, owing to our ordinary classroom methods, most of our school instruction is conveyed through auditory channels and in a verbal form. The teacher explains his topic to the pupil by word of mouth; and the child is expected to imbibe what is said through the ear. Auditory imagery would constitute, for most listeners, the usual and more natural way to retain such oral instruction. There can be little doubt that many backward children are very ill-equipped for this purpose; and here we have one suggestive explanation of the accelerated progress that they make directly they are taught on concrete and manual lines.

Of the various subjects of the school curriculum reading is especially apt to occasion difficulties for the child with poor auditory imagery, particularly where it is taught by purely phonic methods. Arithmetic, on the other hand, may give trouble rather to the non-visualizer: for he fails to picture the problem in the concrete, and so often gives an answer which in practical life he would recognize as absurd. In mental arithmetic the visualization of figures and of number-schemes occasionally helps the normal child; and of this, too, the non-visualizer is deprived. Such a child is also handicapped in spelling, in reading when taught by the look-and-say method, and in realizing the concrete significance of verbal descriptions—for example, in geography, history, or instructions for manual work, since here he may entirely fail to call up any visible meaning for the words that he reads. In all these cases a bright child would usually compensate spontaneously for his deficiencies and hit upon some other means or channel; the dullard is doubly penalized.[1]

From a close study of their mental processes, I have become convinced that, in the thinking of the dull and backward, concrete imagery plays a far more important

[1] Professor Pear would add that instruction intended for the mass of

part than it does in the thinking of the more intelligent.[1] The mistakes to which they are prone, and the general way they go to work, confirm what is indicated by the tests: most of them are visualizers; very few are verbalizers. In practical problems they evidently rely primarily on images of a visual or motor type; in their silent reading they are apt to be engrossed by the imaginary utterance or sound of the individual word to the neglect of its meaning. What is more, when they have not been given, or cannot get, a definite image of a word or of a sentence, of an unfamiliar object or of a strange or foreign place, they seem much more at a loss than the child whose thinking proceeds by vaguer, more abstract, and schematic forms. For the dull mind, for the child whose attention is slow to grasp ideas of things not actually present, the vividness and stability of such images are of great importance. With nearly all of us, when the situation of the moment demands no immediate action, or when immediate action is impeded, mental images arise very readily: thus their chief functions, it would appear, are, first of all, to aid constructive fancy, and, secondly, to provide possible clues when some problem calls for solution. For these purposes, therefore, the dull child will be peculiarly handicapped if he is un-

adults might also be made more concrete. In another of his suggestive articles on imagery, he contrasts the effectiveness of two would-be social reformers—the speaker who quotes figures from a blue-book and the demagogue who draws a picture of a rat emerging from a mildewed wall above the cradle of a baby; and goes on to recommend that parliamentary committees should always meet in rooms that are hung with pictures of people for whom they are legislating. The commercial advertiser, whose working psychology is well ahead of the teacher's, has already grasped these points; and his ingenious artifices might be copied with much success in the backward classroom.

[1] Psychologists have been ready enough to admit differences in imagery; but they seem to have overlooked the possibility of differences in the *value* of such imagery for different persons. Being themselves for the most part abstract thinkers, dependent but little upon concrete representations, and well practised in language-habits, they are disposed to exaggerate the prevalence of imageless thought and the importance of speech-habits in ordinary thinking. The study of children leads me strongly to support the views of Professor Pear: 'The early belief in types of imagery has produced in some quarters a natural reaction which appears to have gone too far' (*Brit. J. Psych.*, XIV, p. 292; cf. *ibid.*, XVIII, esp. pp. 9 and 13).

able to form concrete images or again if he is given no concrete materials from which to construct them. The brighter child can use words, or the images of words, instead: the dullard seldom does.

There are, however, two points on which the accounts in the ordinary psychological textbook need correction or extension. First, it is not made sufficiently clear that images are rarely exact and permanent photographs of the things they purport to represent. Go back to a house you have not visited for many years, and you will be astonished to find how, with the lapse of time, your memory of it has become unconsciously twisted out of shape, like an acquaintance who has aged during a long sojourn abroad. I have asked children to reproduce from memory a set of simple diagrams again and again at intervals of about a fortnight. It is well known that such reproductions undergo changes of which the reproducer himself is unaware: but it would appear that with dull children these distortions are greatest and most erratic. Their memory-images are singularly untrustworthy and unstable. Directing their attention to the crucial points, with extra repetition, more frequent revisions, and an occasional return to the originals themselves, will to some extent correct this tendency.

Secondly, it has never, I think, been pointed out that the functional value of imagery is not to be judged by its vividness alone, but rather by its plasticity—the degree to which it is available for use, the readiness with which it can be called up when wanted, changed at will, and manipulated according to the occasion. These are points on which more accurate investigation is urgently to be desired.

Reasoning.—Among what are termed the higher mental processes reasoning ordinarily ranks as the highest of all. It is on this account that it shows, as we shall see in a moment, a closer correlation with general intelligence than any other intellectual capacity. So consistently do they vary together, at any rate as a general rule, that many have questioned whether reasoning can be classed as a separate ability, and reasoning tests are regularly used to test intelligence itself. Occasionally, however, a bright child is encountered whose powers of logical thought are so poor

compared with his other performances as to suggest a special disability.

J.K., for example, is a boy who is sharp enough in practical affairs, but seems almost incapable of solving any problem where logical thinking is required. He is $12\frac{7}{12}$ years of age, and in the Binet scale has a mental age of 12·5 years; here he can repeat 26 syllables (a test for Age XIV) and draw the holes made by cutting a folded sheet of paper (a test for Age XV which he performs by visualization), but he cannot rearrange the 'mixed sentences' (Age XII) or even explain the absurdities (Age X). In the Porteus maze tests he has a mental age of 13·0 years; in the scale of reasoning tests one of only 10·0 years. He shows great difficulty in grasping relations whether in concrete or in abstract form. In the pictorial completion tests he tries to fit pieces together which a child of nine would immediately see bore no relation to one another or to the incidents depicted. With Healy's puzzle-box he fails altogether to follow the connexions of the various parts, even when their working is explicitly shown to him. On the other hand, in tests of discrimination, mechanical memory, and habit-formation, he is if anything above the normal.

In school work his general level is that of a child of 11½. But his performances are exceedingly uneven. Wherever reasoning is required, he is appallingly backward. This is clearly brought out by his marks in scholastic tests, viz.: Accuracy and fluency of reading, 11·5 years; comprehension of reading, 9·5. Addition and multiplication, nearly 12; subtraction and division, 11; mental problems, 9. Spelling, 10·3; composition, 11·0 (essays often well informed and sometimes inventive; chronological arrangement usually well preserved, but other forms of logical sequence hopelessly disarranged). Handwriting, drawing, and handwork, about 12·5.

Cases such as this certainly suggest that the power to perceive and work with *logical* associations (as distinct from working with *mechanical* associations) and to combine them into an intelligent system may be a relatively specific function. Whether this be so or not, it is often helpful to make a direct study of the child's methods of thought, and

to employ reasoning tests, not merely as measures of intelligence, but as a means of examining the child's power of arguing rationally. When an intelligent but backward child becomes constantly illogical and confused, whether in his English compositions, his arithmetical problems, or his replies to questions in class, it is always wise to ask: is it reasoning as such that causes his difficulties, or merely the subject-matter to which the reasoning should be applied? The issue can be best solved—or best attacked—by giving him tests of reasoning in which the subject-matter is widely varied and always simple and familiar.

As we have already seen, reasoning depends essentially on the power to perceive logical relations, and to relate these relations in their turn, so that they form a coherent whole—a single consecutive argument, valid, consistent, and conclusive.[1] Tests of reasoning, therefore, are concerned chiefly with three fundamental processes, and the questions which they seek to answer are these: Can the child analyse a concrete problem and educe the implied relations? Can he apply relations and so educe correlates? And can he synthesize these relations and correlates into a unitary but complex train of thought?

To test such processes at their simplest a prepared list of words is given to the child, much as in the association tests; and he is required to reply to each one with a word of his own. Now, however, he is not allowed to give any word he wishes; the word selected must stand in some

[1] The supreme importance of logical relations in the higher processes of thought has been made familiar to students of psychology by Herbert Spencer, William James, and C. E. Spearman, each in his own generation. But the doctrine has been hinted at by countless philosophers from Aristotle onwards, and (as Professor Flügel has pointed out) has, 'like a will o' the wisp, been constantly lost sight of, and constantly rediscovered.' Even now its important educational implications still remain to be brought out. Among literary writers, a clear statement of the view I have put forward above was given, curiously enough, by De Quincey in his *Rhetoric*. 'To say that a man is a great thinker is another expression for saying that he has a *schematizing* understanding. . . . His great and peculiar distinction is that he views all objects of the understanding under more relations than other men and under more complex relations. According to the multiplicity of those relations a man is said to have a large understanding, and according to their subtlety a fine one' (*loc. cit.*, p. 57).

specified logical relation to the test-word: it must be an opposite ('Black?' 'White'), or (with other lists) a synonym ('Bad?' 'Evil'), or a whole of which the test-word names a part ('Leg?' 'Body'), or a genus of which the test-word names a species ('Dog?' 'Animal'). Sometimes the logical relations are not single and uniform throughout the exercise, but manifold and mixed, as in the test of Analogies which I have already described.[1] Here, it will be remembered, the examinee is shown three words, the first pair indicating a definite logical relation; and he is required to work a sort of 'rule of three' in words instead of in numbers, first educing the relation obtaining between the first pair of words, and then applying the same relation to the third word, and so educing the requisite correlate—*i.e.*, a fourth word connected with the third in exactly the same way as the second word is connected with the first. For example,

Black *is to* White *as* Bad *is to* . . .?
Leg *is to* Body *as* Wheel *is to* . . .?

Sometimes the logical relations are expressed in complete sentences, and are to be combined to form an inference, as in the so-called test of syllogisms:

Jack is taller than George;
George is taller than Charles.
Who is the tallest of the three?

Here the reasoning is deductive. In the following, inductive reasoning is required:

The person who stole Brown's purse was neither dark, nor tall, nor clean-shaven.

The only persons in the room at the time were—

1. Jones, who is short, dark, and clean-shaven;
2. Smith, who is fair, short, and bearded;
3. Grant, who is dark, tall, but not clean-shaven.

Who stole Brown's purse?

Of these two problems the first should be answered by a child of seven, the second by a child of eight. On these and similar lines tests may easily be framed to exemplify all the commoner modes of reasoning and all the commoner fallacies in logic; they may be graded in difficulty to suit different mental ages. Throughout, the prime essential is that the

[1] Page 51.

solution should turn, not upon material knowledge or interest, or upon ability to understand the words or the ideas, but solely upon the exercise of logical thought.[1]

All the foregoing may be regarded as tests of constructive reasoning. Tests of critical or destructive reasoning are almost equally effective, and have formed the basis of an ingenious scale drawn up by Dr. Ballard.[2] Problems of this latter type are called absurdity tests. They were introduced by Binet into his well-known scale: he gave five absurdities to be explained by children aged eleven. The child, for example, may be asked:

> 1. What is silly in this? A boy said to me: 'I have three brothers, Jack, Tom, and myself.'
>
> 2. A soldier wrote: 'Dear Mother, We are expecting an attack at any moment; and I am writing this letter with a sword in one hand and a pistol in the other.' Can you see anything foolish in what the soldier wrote?

Other investigators have tried weaving a whole series of absurdities into one continuous narrative. The child is required to read the passage, and to point out as many absurdities as he can. The opening paragraphs from one of the earlier of these tests may serve to illustrate the general principle.

A SUNDAY IN FRANCE.

> Ten years ago on a pleasant summer's afternoon in the middle of January 1916, the twelve o'clock express from Scotland was rushing past the busy terminus of the Great Western Railway at twelve miles an hour.
>
> A clean-shaven young Englishman, of about fifty years of age, stepped lightly from one of the first-class carriages and hurried slowly down the platform, with both hands in his pockets, carrying a heavy bag, and gaily curling the tips of his moustache. . . .

In the present inquiry I have mainly relied upon two tests for reasoning—a graded scale of short problems[3] and

[1] See *Journ. Exp. Ped.* (V, 1919, pp. 68 *et seq.*), 'The Development of Reasoning in School Children.' It is not necessary for the problems to be expressed in words: for the simpler forms of such tests sensory material may also be employed—colours, pictures, geometrical shapes or patterns (see *The Subnormal Mind*, pp. 31 *et seq.*, and pp. 55–6 above).

[2] 'The Limit of the Growth of Intelligence,' *Brit. Journ. Psychol.*, XII, ii (1921), pp. 129–31.

[3] See *Handbook of Tests*, pp. 91–4.

a continuous absurdity test,[1] part of which has just been cited. They were a little too hard for some of the younger members of the backward group ; and for these I added a test of opposites and Ballard's absurdity tests, slightly modified. Most of the children in both groups took all four tests ; but with the older and brighter the results of the former were given the chief weight, and with the younger and duller the latter. The figures obtained are shown in Tables XXIII and XXIV (pp. 466, 468). In the backward group it will be seen that, next to memory, reasoning is the function in which the retarded child is most deficient. But here again we should distinguish between the two sub-groups. Among the dull, reasoning power is, almost invariably, much poorer than memory. Among the merely backward, memory is very often much weaker than power to reason. This is clearly seen on tabulating the figures for the two groups separately, as in Table XXVI.

The correlations between the results of the reasoning tests and those of the Binet tests of intelligence are extremely high : ·83 for the normal group and ·72 for the backward. It is for this reason that, as already noted, tests of reasoning provide one of the best methods available for testing general intelligence—better, at any rate, than any other test of a single mental capacity. The correlation with intelligence, however, is still far from complete ;

TABLE XXVI. DEFECTS IN REASONING AND MEMORY AMONG DULL AND BACKWARD CHILDREN

	Reasoning.		Memory.	
	Dull.	Merely Backward.	Dull.	Merely Backward.
Ratio [2]	74·3	89·4	78·7	84·1
Frequency of definite defects [3] .	55·3	15·1	21·2	28·8

[1] See *Mental and Scholastic Tests*, p. 237.

[2] As usual the ratio is calculated by the formula :

$$\frac{\text{Test-results expressed as a Mental age}}{\text{Chronological age}} \times 100$$

[3] Expressed as a percentage. As usual a child retarded by 15 per cent. (or more) of his age is considered to be suffering from a definite backwardness or defect.

and this raises once again the question I have already touched upon: namely, to what extent does reasoning, or what is loosely called by that name, involve some specific ability or group of abilities, as distinct from the general factor termed intelligence? My own view is that, as tested by the methods described, it depends partly upon a teachable technique, which is, as a rule, unconsciously acquired, and partly upon specific capacities for dealing with relations of particular kinds. But it would be out of place to argue such controversial issues here.

Over the practical inference that emerges from these figures there can be no dispute. Logical thinking is beyond question the process in which the dullard's weak intelligence is most flagrantly displayed. And the inference is amply borne out by daily observation.

Both in the tests themselves and in the everyday work of the classroom it is well worth noting the nature of the errors in reasoning to which the child is prone—the actual occasions of his logical failure. Broadly speaking, the dull child seems to fail in three main ways: first, from sheer inability to single out and see relations; secondly, from inability to combine the relations and the related data into a systematic whole, particularly where the whole involves some degree of complexity; thirdly, from inability to sustain the directing idea which should guide the evolution of his apperceptive processes, both in analysing the whole and in building it up again. He is like a man who tries to build a house without mortar to join the bricks, and whose pile of bricks consequently begins to topple over when it reaches a certain height, and who all the way through is apt to forget the plan he started with, so that the front does not match the sides and back, and none of the walls are properly fitted on.

One of the commonest sources of bad reasoning springs from what I have elsewhere called 'suggestive dominance.'[1] Some salient item in the test-data seizes and absorbs the child's attention, and operates illogically to the exclusion of the rest. Take, for example, J. K.—the twelve-year-old boy whose inability to reason I have already described, and

[1] *Journ. Exp. Ped., loc. cit.*, p. 17.

consider his answer to the following question. 'It looks like rain, but I shall stay indoors. Shall I want an umbrella to-day?' That is a simple problem which is usually solved correctly by an average child of 7. But the mere mention of rain in the first premiss is apt at once to arouse a vivid but misleading picture. J. K.'s mind seizes on this outstanding idea, and fails to relate it to the next—the vaguer idea of 'staying indoors'—which, though less concrete, should dominate over the first instead of being submerged by it. As a result, the lad jerks out: 'Yes, he'll want an umbrella.'

It is mental processes of this sort that made J. K.'s teacher complain that 'he is such a wild guesser.' Guessing, in this reference, usually means blurting out an answer which is suggested by some mere mechanical association, instead of one which is appropriately educed as a result of a clearly perceived logical relation. The guesses, however, are not altogether 'wild.' Nearly always it can be seen that there is some word or notion in the phrasing of the question that catches the interest of the child, gets firmly lodged in his thoughts, and then starts germinating by itself, as it were, regardless of the total context. The irrational mind is a suggestible mind, uncritical and credulous: it immediately accepts any well-defined thought that its own mental machinery brings prominently forward, however irrelevant or absurd.

In the classroom such tendencies account for most of J. K.'s blunders in simple arithmetical problems. They reappear, though not so glaringly, in his English compositions. His sentences are fluent enough, and go tumbling on with a crude vigour and speed; but, as his master puts it, 'his ideas are continually running away with his pen.' All through, except where he is merely recounting a recollected train of events, the sequence is slipshod and erratic: there is no unity, no order, no cohesion. Writing on so simple a subject as 'School,' he entirely omits to marshal his statements according to any prearranged plan. Co-ordination is effected chiefly by 'and,' occasionally by 'when,' and once by 'so.' 'Since,' 'because,' 'if,' and 'but' he never employs in this or any other composition. Almost every sentence starts a new sub-topic: and he persistently reverts to points already done with. The

whole essay is an unassorted list of inconsequent remarks, as disjointed as a page from a dictionary. And in all that he writes—notes, diaries, personal letters, answers at examinations—the movement of his thoughts is guided simply by accidental connexions, by obtrusive memories from his own personal experience, by unanalysed associations of time and place, never by the methodical development of a sustained argument or theme.

As a rule, teachers are apt to notice a child's failure to reason most of all in problem arithmetic. But it is rather in his efforts at composition that the special nature of such failures, and often their causes, come most plainly to light. Hence, particularly with the child who, though backward, is of normal intelligence, composition is generally the subject that most rewards a patient study.[1]

Summary of Results.—I cannot pretend to have covered all the intellectual functions of the mind. But I have touched upon those that come chiefly to notice in sorting out the causes of educational backwardness in the classroom. Of the different disabilities I have mentioned, the relative importance may be gauged by reviewing the list of figures in each table as a whole (Tables XXIII and XXIV, pp. 466, 468).

Table XXIII brings together the ratios obtained with tests of capacities that seem more or less specific. Here the control group—drawn, it will be remembered, from much the same social class as the backward—appears to be slightly below the average in all the tests: the divergence is most perceptible in tests of reasoning, attention, and speed of association. Nevertheless, the backward groups fall still more below the average in every instance. Psychologically,

[1] The teacher commonly objects that, unlike their sums, children's compositions do not lend themselves so readily to quantitative marking. In *Mental and Scholastic Tests* I indicated the deductions that could be drawn by three simple modes of counting: (i) length of sentences; (ii) size of vocabulary; (iii) frequency of logical connectives (cf. pp. 331 *et seq.* and Table LXII; the reader may convince himself of this, if he compares, say, a leader from *The Times* and the *Daily Worker* on this basis: the differences are so significant that the source, if unknown, could be demonstrated in this way). On more elaborate marking, see *Mental and Scholastic Tests*, p. 359 (2nd ed.), and B. M. D. Cast, 'The Efficiency of Different Methods of Marking English Composition,' *Brit. J. Educ. Psychol.*, IX, pp. 257–69, and X, 49–60.

we might say, the backward are characterized by the following defects, and that in the order stated :
Defects in—

Reasoning Long-distance mechanical memory Short-distance logical memory Short-distance mechanical memory Long-distance logical memory Duration of attention	ratios below 85
Speed of association Scope of attention Auditory perception Visual perception	ratios above 85

Reasoning and long-distance mechanical memory are the only capacities in which the backward are as defective as they are in general intelligence and school attainments.

But to a large extent these defects must be the inevitable outcome of a defect in intelligence ; for (as shown by the correlations in Table XXVII) the order of the frequency of the several defects among the backward is very much the same as the order in which the corresponding capacities are dependent on intelligence. Accordingly, we have still to discover whether *specific* defects in these capacities, independent of any marked shortcoming in intelligence, can cause backwardness. Let us therefore pick out those children in whom the disability is apparently specific—*i.e.* unaccompanied by marked defect in intelligence—and see what is their relative frequency within the whole groups.

In Table XXIV I have given the percentages of children suffering from specific disabilities as defined above.[1] But by simply comparing the proportions found among the backward and in the control group, it is not easy to judge

[1] See p. 468. Since the long series of specific tests could not be applied to the entire groups, the figures in this table have large sampling errors (see Appendix III) ; and therefore the differences between the results must not be too closely pressed. For the reasons explained above, the two tests for logical memory were applied to so few boys and girls that it is impossible to calculate percentages ; and these are consequently omitted from Table XXIV.

the relative influence of each factor. Accordingly, as before, I have applied the tetrachoric method, and have reduced the data to the form of a correlation. The coefficients are appended in the last column. Since in the case of these capacities we have graded measurements for all the characteristics to be compared, we can also calculate the correlations by the more reliable method of product moments. What we are considering is the influence of *specific* disability, *i.e.* the influence of a backwardness in some particular capacity, after the effects of a backward intelligence have been allowed for: consequently we must take not the total but the partial correlations. In the second column of Table XXVII I give the observed or 'total' correlation of the test-results with educational

TABLE XXVII. CORRELATIONS OF SPECIFIC INTELLECTUAL CAPACITIES WITH EDUCATIONAL ATTAINMENTS

	Correlation with Intelligence.	Correlation with Educational Attainments.		
		Total.	Partial.	Tetrachoric.
Educational:				
Reading . . .	·63	·66	·38	·38
Arithmetic . . .	·59	·60	·31	·25
Psychological:				
Visual Perception .	·21	·21	·09	·11
Auditory Perception .	·25	·29	·16	·28
Scope of Attention .	·61	·56	·22	·31
Duration of Attention .	·58	·57	·27	·37
Speed of Association .	·44	·37	·08	·04
Mechanical Memory (Immediate) . .	·52	·58	·35	·51
Mechanical Memory . (Delayed) . .	·48	·67	·53	·60
Reasoning . . .	·77	·72	·37	·57

attainments, and in the first column their correlation with intelligence. Intelligence correlates with attainments to the extent of ·72. From the three figures we can compute for every test the partial correlation between its results and those of the educational tests, when the influence of intelligence on both has been discounted. The resulting coefficient is given in the last column but one.

For comparison I print again in the last column the coefficient calculated by the tetrachoric method.[1]

The implications of the two coefficients are not precisely the same. The product moment coefficient answers a more general question: how far does a specific capacity affect educational attainments for ill *or for good* in a group whose intelligence is uniform ? The tetrachoric coefficient answers a narrower question: supposing we took backward groups and control groups of equal intelligence, how far should we find the backwardness due to this or that specific disability ? In the second case we only inquire how far does a very poor memory (say) cause definitely backward attainments; in the first, we also consider whether milder disabilities may have similar but milder results, and whether a good memory also contributes towards high attainments. Allowing for this difference in the problems which they answer, the two sets of coefficients yield fairly consistent results ; and we may here see some confirmation of the validity of using the tetrachoric method for those cases where we could secure no independent check from detailed measurements.

The tables show clearly which of the specific disabilities have the greatest effect on school work. The most influential is evidently a defect in delayed mechanical memory: thus, next to weak general intelligence, weak memory, in the popular sense of the word, seems the most important of all the mental causes of backwardness. Defective reasoning, and to a less extent defective attention (as measured by the tests), perhaps, too, defective auditory perception, seem likewise to act as specific factors retarding school progress (cf. especially Table XXV). On the other hand, slow speed in the association of ideas—or rather in the association of words in which to express them—was a

[1] With the psychological capacities, the probable errors of the total coefficients range from $\pm$ ·03 for correlations of about ·7 (*e.g.* reasoning) up to $\pm$ ·06 for correlations of about ·2 (visual perception): those of the partial coefficients may be taken as of the same order, so that the figures for visual perception, auditory perception, and speed of association, are not statistically significant. With the tests of reading and arithmetic larger numbers were tested : hence the probable errors here sink to $\pm$ ·c2.

characteristic feature of both the groups examined, normal as well as backward. I infer, therefore, that this is largely an indication of the poor cultural environment from which both groups have been drawn. For the rest, the slight difference in this respect between the backward and the normal is almost wholly attributable to their poorer intelligence: the partial correlation drops to ·08; and there is thus no sign that lack of fluency operates as a specific or additional factor.

It is interesting to observe that backwardness in reading and backwardness in arithmetic also operate as specific disabilities. Their frequency and their degree are by no means solely an incidental outcome of backwardness in general intelligence. Of the two, backwardness in reading appears to exert the more detrimental influence.

In conclusion, I must repeat that both the methods and the results described in this chapter are avowedly rough and tentative; and consequently no great stress can be laid upon them. I describe them here chiefly because they seem to suggest fruitful directions for future research. Above all, I would not have it supposed that the mind can be split without remainder into a set of separable pieces, all labelled and numbered like the spare parts of a car. For practical purposes, and above all when anything goes wrong, it is exceedingly helpful to take tests at definite points, and jot down each result in a single figure. But this is no more a final description of the living child than Olivia's inventory was of her person: 'item, two lips indifferent red; item, two grey eyes, with lids; item, one neck, one chin, and so forth.' Beauty, it has been said, 'may be seen or may be painted, but cannot be summed up in a schedule.' The same is true of the mind.

Treatment of Specific Disabilities.—There is a rooted and a widespread notion that one of the main tasks of education is to train those faculties in which the individual child is weak. Is his memory forgetful? Then plenty of 'repetition'—learning poetry, dates, or tables, day after day—should be given to improve his innate retentiveness. Has he an illogical mind? Then solving mathematical problems or construing Latin prose will steadily develop his

powers of reasoning. And many a teacher will still contend that hard lessons on subjects for which the child can have no further use, and in which he takes not a particle of interest, should nevertheless be retained in the syllabus for the backward class, because of the intellectual exercise which they are supposed to afford, just as chewing hard crusts, with neither taste nor nourishment, is supposed to strengthen the teeth and the jaws.

Popular as they are, all these assumptions run entirely counter to the views now held by nearly every educational psychologist. The various capacities that I have been naming are no longer regarded as faculties that can be strengthened automatically by a course of mental gymnastics. A lengthy series of careful investigations has shown that the effects of such training are exceedingly limited. Practising a child in one set of exercises does not result in any wide transfer or spread of the improvement so obtained, nor will other mental activities called by the same name—memory, observation, reasoning, or the like—inevitably benefit as a consequence.

Personally, though I fully accept this conclusion, I believe that the practical corollaries so often drawn from it are inclined to go too far. The power to visualize, for example, is generally described as an inborn gift ; hence practice, it is said, cannot change it. Nevertheless, disuse or lack of practice usually leads to atrophy; of that there can be little doubt : and experiments I have made with children strongly suggest that exercises appropriately arranged will increase, not perhaps the vividness of visual imagery itself, but certainly the use that is made of it. The processes of memory and of reasoning in particular are so essential in all school work that it would be fatal to declare that we must give up every child as hopeless who seems lacking in one or other of these capacities. Here, as elsewhere, the problem that now faces the educational investigator is not so much whether transfer of training ever occurs. It is universally admitted that it sometimes does, though in most cases the amount must be relatively slight. What future research has to discover is this : under what particular conditions does such transfer take place, and how can it be

raised to a maximum? Meanwhile, until we know the nature of these conditions, it is of little use advising the teacher to cultivate, by mechanical practice and daily drill, those capacities which are known to be weak or wanting.

What, then, can be done? If a child's backwardness is due to his bad memory or his bad reasoning, is there any way of overcoming the effects of such a weakness? In answer, a few deductions from the theoretical studies of the psychologist may be suggestive. Most of them have been tried out in practice, and found effective.

Although we cannot directly improve a child's weak memory, we can teach him to make a more efficient use of what little memory he has. The teacher, therefore, who has to deal with the forgetful pupil, might well familiarize himself with the innumerable devices and practical rules suggested by work in the laboratory. I may briefly recapitulate the more helpful here.

(i) Begin by making the work to be memorized at once more interesting and more intelligible. Meaning is a great aid to retention. Hence, if a child's intelligence is stronger than his memory, let him use intelligent learning to supplement mere parrot-like reiteration. Intelligent learning is six times as quick, and ten times as lasting, as mechanical repetition.

(ii) Generally speaking, memory depends, as we have seen, upon association. Hence multiply associations; devise as many different cues and reminders as possible for prompting subsequent recall.

(iii) Get the child to appreciate the precise nature of the associations as far as he can; help him to understand *why* things are related: and so let him rely less on arbitrary links, blindly hammered home, and more on conscious and logical connexions.

(iv) If there are no obvious rational links, do not scruple to invent fanciful connexions or to use artificial mnemonics.

(v) It is better to learn in wholes rather than in sections, *e.g.* two or three verses at a time instead of single lines. The length of the whole should be appropriate to the child's scope of attention.

(vi) In learning by this method let the child observe

first the general scheme or arrangement of the whole. If the material is at all extensive and complex, let him make a systematic outline, either mentally or in writing, of the leading features.

(vii) Exploit whatever form of imagery is most vivid for each particular child. Let the visualizer make mental pictures. Let the motor type use movement: reading aloud or half aloud is often better than mere silent reading; sometimes writing is better still. With the audile, make the most of rhythms, rhymes, alliterations, and the expressive inflections of the voice.

(viii) Mild emotion, particularly pleasurable emotion, tends to stamp in whatever it accompanies. Excessive emotion, particularly painful emotion, distracts. Learning, therefore, should be a soberly exciting process, gratifying and full of interest rather than obnoxious or dull.

(ix) Give the child a natural motive for learning whatever he has to learn, and see that he concentrates keenly during the learning spell itself. The will to learn is half the battle. The best of us find it difficult to memorize a needless string of pointless facts: but, when the knowledge of the facts will plainly help to solve some problem over which our curiosity has just been kindled, we throw our whole soul into the task. Accordingly, always find an incentive.

(x) Between the pupil with a bad memory and the pupil with a good memory the main difference is simply that the latter can get a thing by heart after a very few rehearsals, while the former may require to go over the same thing again and again. Here the old-fashioned teacher was partly in the right: keep ramming, and the simpler facts will ultimately stick in the hardest of heads. With the dull, therefore, the chief principle will be to introduce plenty of extra drill on whatever has to be learnt; only the drill must never be tedious: short, sharp, oft-repeated efforts will be found the most effective.

(xi) After intensive application let the child's mind rest a while before turning to a new task: what he has just learnt will go on quietly consolidating, as jelly sets best in an undisturbed mould.

(xii) Let his later repetitions be active attempts at reproduction with a minimum of aid ; but do not test him when he is likely to go wrong, else you may only succeed in driving home his errors.

(xiii) Employ revision far more frequently than you would with the normal child. It is a good plan to spread out the repetitions as much as possible : for example, if only two hours can be spared for learning a piece of material, it is false economy to spend the whole of this time consecutively at a single sitting. One hour on each of two successive days will yield a better return ; four half-hours on four different occasions would be more profitable still ; and so on, up to obvious limits depending mainly on the individual and the material. The best results will be secured if the intervals between successive revisions are spaced out progressively : let the child try to reproduce what he has learnt immediately, then after half an hour, then after twenty-four hours, then after two days, a week, a month, and so on.[1]

Disabilities in reasoning are harder to circumvent. Reasoning, like memory, is often supposed to be an inborn capacity, or at any rate a mode in which the inborn capacity called general intelligence may manifest itself. In practice, however, as I have already maintained, logical reasoning turns largely on a number of teachable tricks. It is as easy to teach a child to avoid the more notorious forms of fallacy as it is to teach him to avoid subtracting his figures in arithmetic when he ought to add them. The whole body of mathematics is, in fact, little more than a systematic compendium of rules for a special branch of logic.

Reasoning, we have seen, consists in working with relations : and for the dull child the first and foremost difficulty is to isolate and grasp each abstract relation as it arises. He is usually a child whose attention can seize only one factor in a situation at a time : he is expected to seize two, and, what is more, to observe how they are connected. The success

[1] The teacher who has trouble with non-retentive pupils should study the chapters on memorization in any good textbook of Educational Psychology. H. J. Watts's little book on *The Economy and Training of Memory* (Edwin Arnold, 1909) will be found particularly instructive.

of the effort does not depend solely upon sheer perspicacity of intuition or simple insight. The most discerning scientist invokes artificial aids; he ekes out his powers of comprehension by inventing symbols, formulæ, graphs, and similar contrivances for fixating the attention and making the abstract concrete. Analogous devices may be exploited by the resourceful teacher for helping the younger child. Dr. Neurath's pictorial conventions, first systematically employed at the Vienna *Mondaneum* for explaining statistical comparisons, and since widely popularized for many different purposes in various continental schools, afford perhaps the best-known educational example of this simple but fruitful principle.

The second main difficulty is to fit and hook together a number of abstract relations into a consecutive chain. Here the safest method of approach in teaching the slower pupils will be to make absolutely sure of each short step, or short series of steps, before the whole argument is attempted. In arithmetical problems, for instance, keep first of all to sums involving one or two steps only. Teach these by numerous concrete examples of a naïvely simple kind, until the mental manipulation depends on an established habit rather than on a special spasm of concentrated thought. Then combine the elementary habits into a more complex habit, and exercise that. The ground-plan of a more intricate argument will be easier to follow if once again a visible outline is used. Many a proof that sounds abstract and involved in words can be rendered intelligible if the underlying scheme of thought is presented to the eye in a diagrammatic form. For example, the validity of a deductive inference becomes obvious at once when translated into terms of Euler's syllogistic diagrams; and an inductive inference which depends on the elimination of classified alternatives becomes equally convincing when the alternatives are set out like a genealogical table—the device adopted, as readers of detective stories may remember, by one of the most successful superintendents that Scotland Yard is said to have produced.

Similar principles may be employed to assist the child with poor powers of observation. Teaching him what to

look for, giving him names for the features to be picked out, and a systematic scheme to follow, encouraging him to build up a habit (or perhaps I should say an ideal) of observation, and, above all, creating an interest in whatever he has to observe—this will be far more effective than trying to 'train the faculty of observation' by the method of indiscriminate exercise.

For the rest, the safest practical rule for the teacher who has to deal with children suffering from special disabilities will be this: find out what is the fundamental nature of the process that is specifically feeble, and then seek some alternative process which may be counted upon to lead to the same result. If the child is weak in visual analysis, help him to dissect visible material by actually taking it to pieces with his fingers: in reading and spelling, for example, use movable words or letters. If he seems unable to visualize word-wholes, do not teach him to read by the 'look-and-say' method, but use the phonic or alphabetic method instead. Conversely, if he is weak in auditory imagery, discard the phonic method and substitute the 'look-and-say.' And, generally, discover what capacities or interests are strong as well as what are feeble, and, so far as possible, rely mainly on the strong.

In 21 of the backward cases in London—approximately 5 per cent.—I could find no cause for the backwardness, except some specific disability of the type described above. With each of them it was possible to carry out remedial education on the lines just indicated. The response was surprising. During the first 12 months their average progress was equivalent to 2·2 educational years. Fourteen had a mental ratio of 100 or more: at the first survey their educational ratio averaged 78; 3 years later it averaged 98·5—practically normal. From this, and similar results with many other cases, I conclude that, *although defect in general intelligence inevitably places a definite limit to educational progress, defect in special intellectual abilities rarely does so:* by appropriately modifying the methods of instruction, it can almost always be circumvented.

CHAPTER XV

DEFECTS OF TEMPERAMENT AND CHARACTER

Residual Cases.—It will be remembered that in 14 per cent. of our cases it proved impossible to explain the child's educational backwardness by any of the factors most frequently adduced—lack of general intelligence, physical ill-health, irregular attendance, poor home circumstances, and the like. We were therefore compelled to seek some more specific mental cause. Such causes we have now partly run to ground in the various specialized disabilities that tend to hamper intellectual work. Yet, in common with most recent investigators, we have found these obscurer defects to be far rarer than is popularly supposed; at most they account only for another 5 per cent. of our cases. What, then, can be the explanation in the remaining 9 per cent.?

One final field of search is left. The only mental factors we have not yet brought under review are what may be broadly termed the temperamental or emotional—in technical terms, the conative as distinct from the cognitive.

Temperamental Defects.—There is a widespread notion that disorders of temperament and conduct are matters primarily for the physician. At many clinics, for example, the psychologist tests intelligence and school attainments, and the temperamental aspect is left to the psychiatrist. For this perhaps the psychologists of the past are in part responsible, since they treated the mind as little more than an intellectual machine, and tacitly assumed that temperamental conditions were of no account unless they amounted to a definite pathological disorder. In this country, however, long before Freud and the psychiatrists had drawn attention to the importance of emotional factors, psychologists like Stout, McDougall, and Shand had strongly insisted on the part played by primitive and

irrational impulses in ordinary everyday life, and had laid stress on the dynamic aspect of the mind.

Among school children, mental abnormalities such as figure in the ordinary psychiatric textbook are comparatively rare ; and the milder disorders can be observed better by the teacher than by the doctor, and perhaps better by the psychologist than by either. The teacher can note the everyday behaviour of the child in the classroom or the playground ; but it is difficult for him to penetrate behind the conventional mask that almost every pupil wears while under the teacher's eye. Just because he is a teacher, he will find it hard to induce the child to lay bare the inner secrets of his mind. The psychologist, on the other hand, is free to fraternize: he can sympathize with the impulses on which teachers are obliged to frown, and that without incurring the least suspicion of favouritism : he can speak to the unruly urchin in the lingo and accent of his class without risking any loss of dignity. Nevertheless, he is, as a rule, severely limited by time. In exploring the possible causes of such milder troubles as concern us here—laziness, disobedience, petty dishonesty, and the like—a single interview is not likely to be very effective; and the psychologist must still rely on the daily observations of the trained and experienced teacher in the classroom. The teacher, therefore, should know something of the modern psychology of motive, and must not restrict himself solely to noting the intellectual failings of his pupils; he must be equally alert to observe the weaknesses and the idiosyncrasies of their individual characters.

The Study of Conative Factors.—Modern psychology insists that all intellectual activity must be inspired by a motive—driven by the pressure of emotional energy, however gentle or slight. No engine can be run without a supply of power; and the mechanism of the mind is not an exception. The best-made car will stop on a hill if the petrol gives out; and, similarly, we may find that a child comes to a standstill in his work, not because of defects in his intellectual machinery, whether general or specific, but because of some shortage or leakage of moral energy or will. Accordingly, our examination of cognitive capacities

must be supplemented by a study of the child's emotional incentives.

For assessing emotional traits, as distinct from cognitive, tests have so far proved of little value.[1] The psychologist, therefore, is compelled to rely first on the reports of those who know the child personally at school or at home, and secondly on his own observations as he notes the child's demeanour while he tests him, questions him, or encourages him to play freely, both alone and with other children, in an appropriately equipped playroom. Here as elsewhere the time-honoured method of the personal interview needs to be amplified and refined, and above all to be supplemented by observing actual behaviour at first hand in practical but standardized situations.

Temperamental Instability.—Into the psychology of temperament I need not enter further. Its nature and importance in the school child, how it may be systematically examined and what points should be studied and observed, I have discussed in earlier works. Here it will be sufficient to repeat that I accept the current doctrine that the foundations of individual character may be conveniently described in terms of the common instincts and emotions that all mankind is supposed to inherit.[2] It follows that,

[1] I have discussed tests, rating scales, schedules, and other methods for analysing temperament and personality in *The Subnormal Mind*, pp. 42–57, 317–35, and in *Brit. J. Educ. Psych.*, XV, pp. 107–22.

[2] My use of the 'so-called doctrine of instincts' has been criticized as implying acceptance of an unsubstantiated theory. For a defence of that theory I may refer to my papers in *Brit. J. Educ. Psych.*, XI, pp. 155–72, XIII, pp. 1–15. Here my interest lies rather in the practical issue. What the practical psychologist wants to know is this: granted that in the past a given child has been known to commit such and such actions with such and such frequency, and to react to such and such situations with this or that form of emotional display, what actions and reactions can we predict in the future? Thus stated, the problem becomes one of correlation. On making a statistical analysis of my cases, I find that certain actions or reactions tend to go together: the child who sweeps my test material to the floor when he fails to solve the puzzle and turns sulky when he is reprimanded, is, so I learn from further inquiry, also given to fighting with his playmates at school and to losing his temper with his brothers and sisters: he is not so likely to start at sudden sounds, to run away when challenged, or to turn shy with strangers. Conversely, the child who is shy with me is, so I find, often shy with others; he tends to display the last group of reactions

so far as innate factors are concerned, disorders of character may be considered as arising mainly from the excessive intensity with which one or more of those emotional impulses are inherited by the particular child in question. Accordingly, in assessing temperament and character, I take the conventional classification of the emotions, with their correlated instincts, as affording the most useful headings under which the various facts may be noted.

Where all these instincts and emotions are developed to an excessive degree, and the child's behaviour and intellectual processes are as a result entirely unbalanced, I designate the child 'unstable.' Instability of this order may be a definite cause of backwardness; but in different

I have mentioned, but is not so likely to fight, sulk, or lose his temper. I infer two distinct statistical 'factors'; and, for simplicity, I call them 'anger' and 'fear' respectively. Since, too, in these respects the child's behaviour to-day often resembles his behaviour in early infancy and that of his relatives, even when he has not lived with them, I assume another set of correlations, which I describe by saying that these factors seem, in part at any rate, to be hereditary or innate. But again I am not concerned with the biological transmission of these tendencies: by hereditary I merely mean that it is possible to infer from the behaviour of the child's brothers, sisters, or parents, what will probably be his own behaviour, even when the training and the social influences to which he is subjected have been altered or improved. And generally I find that the popular account of instincts does in some measure reflect the way in which groups of behaviour-tendencies are apt to go together and so make practical predictions more or less feasible. Perhaps, on the conative side, it would be as well to avoid the word instinct, just as in cognitive psychology we now avoid the word faculty. In the past, critics, who have been concerned to deny the 'existence' of general intelligence, have unwittingly raised doubts about the intercorrelations of intellectual performances and the possibility of prediction—points which in practice they themselves regularly assume. In the same way those who question the existence of 'instincts' may at times obscure a practical issue by raising theoretical difficulties which in themselves are undoubtedly justified. The question is not so much whether a man's actions are so specific that they cannot be explained in terms of instincts, but how specific are they: what predictions can be made and with what probable error. Hence, what is most urgently needed is a more systematic application of the method of correlation to various conative symptoms, as manifested both in the individual and in his relatives, in much the same way as correlation has been applied to the determination of a general intellectual factor, and of its similar manifestations in different members of the same family. The resemblances between individuals belonging to a special 'type' may conveniently be assessed by correlating persons instead of tests or traits.

individuals it operates in different ways. In the main it is possible to distinguish two broad types of instability—the excitable or unrepressed, and the repressed or sensitive.

The Excitable and Unrepressed.—Nearly 20 per cent. of my backward cases were of an excitable and obviously emotional type. But the proportion varied widely from school to school and from district to district. There was, too, a high percentage of such cases in the control groups; but this no doubt is partly because the children in these groups were drawn from much the same neighbourhood as the backward. (See Table XXVIII.)

TABLE XXVIII. TEMPERAMENTAL AND NEUROTIC CONDITIONS

	Control Group.			Backward.			Correlation with Backwardness.
	Boys.	Girls.	Average.	Boys.	Girls.	Average.	
Temperamental Conditions:							
Unstable:							
(*a*) Excitable .	11·9	7·6	9·7	21·2	18·7	19·9	·24
(*b*) Repressed .	4·7	5·6	5·1	7·8	10·1	9·0	·16
Lethargic . .	1·6	2·0	1·8	5·2	3·0	4·1	·20
Nervous Conditions:							
Anxiety states .	2·6	4·0	3·3	6·2	6·6	6·4	·17
Neurasthenia . .	1·0	0·0	0·5	2·6	1·0	1·8	·26
Hysteria . .	0·0	0·5	0·3	0·0	1·5	0·8	·19 [1]
Minor neurotic symptoms . .	13·0	16·7	14·8	16·1	20·2	18·2	·07 [1]

In London it frequently happens that an illiterate and excitable population will collect in definite areas and congregate in particular streets. Sometimes they seem to be attracted to the quarter by the cheap facilities for amusement; sometimes their own noisiness and rowdiness prevent them from getting or keeping rooms in a quieter road. Like gravitates to like; and always an excitable person prefers the company of others who are as excitable as himself: and so a sort of tone or tradition of demonstrative behaviour grows up, and becomes distinctive of the district.

Every wanderer in a large town must have been impressed by such differences. He will notice that some of the most

[1] Not statistically significant.

populous and poverty-stricken slums are nevertheless peaceable and staid ; and then he strikes a shabby thoroughfare that swarms with clamorous youngsters, squealing babies, and quarrelsome bullies and roughs. Youths are shouting over their games in the road ; girls are giggling with each other or calling after the boys : at one end there is a hurdy-gurdy playing jazz for juvenile dancers, and at the other a knot of unsteady drinkers singing hilariously outside a public house.

If the visitor drops in at the nearest school, he will usually find it packed with backward pupils. The head master will probably relate that, when he first took over the post, he thought he would never succeed in bringing discipline and order into the classes under his charge : industry and attention were nowhere to be had. He will tell stories of the numerous conflicts his youthful hooligans have had with the police. And in the schoolroom, he will add, the young rascals, though amusing and likeable enough, seem incurably restless, thoughtless, and ignorant. In every standard the level of the work will be a year or two below the normal. Nevertheless, it is amazing, as I shall show in a moment, to see what a patient teacher, who is prepared to make full allowance for such temperamental creatures and to plan his syllabus along appropriate lines, can extract from this unpromising material.

The recent attacks on the problem of the slums—dispersing the more troublesome families and re-housing the remainder in scattered districts elsewhere—have to some extent diminished the number of such schools. But there is hardly a single department without one or two youngsters of this type. They are found in the secondary school as well as in the elementary.

The excitable child is easy to recognize. He is fidgety, jerky, and impulsive. All his judgments are rash, and all his actions hasty. At once clumsy and precipitate, every movement that he makes is ill considered, ill co-ordinated, ill controlled, impelled far more by feeling than by purpose. Indeed, his body seems almost as unbalanced as his mind. The features of his face are excessively mobile ; and its expression is changeful, exaggerated, and often marked by

a queer asymmetry. The muscles, particularly those about the eyes and mouth, are overactive, and those about the forehead corrugated with habitual wrinkles. His speech is sometimes husky, sometimes a shrill staccato, nearly always voluble and fast. While he is engaged in conversation, his hands are perpetually in motion, fingering and playing with each other or with any object in reach. The boy tugs at his coat-buttons or rattles the halfpennies in his trouser pocket; the girl picks at her handkerchief or pulls at the pleats of her skirt.

Even as they sit working in class, such children can be quickly singled out. They are constantly looking about them, their eyes everywhere but on their work. However much they are told to sit still, they keep changing their posture—shifting their arms or shuffling their feet. When free, they are active, boisterous, full of noise and energy. In the playground and the street their conduct is unmistakable—wild, reckless, and inconsequent. Excitement they crave for. Reading and indoor occupations are too quiet and still. Always they live in a state of acute emotion: each impulse is intensely felt, and put immediately into action regardless of its fitness for the moment. Yet, rightly understood, they are not so intractable as might be thought. They are prone to good emotions as well as bad, to the social as well as to the aggressive. Sorrow, anger, fear, sex, affection, self-assertion, self-submission—each instinct as it comes uppermost governs the child's mood, and then quickly gives way to another, till the observer is left wondering what the child will do next. But, by playing on the right motive, such youngsters can easily be won over and led, and eventually shepherded by diplomatic management back into the proper path.

On the intellectual side, their wits are at the mercy of their feelings. Their ideas are sudden, incongruous, and erratic. As a rule, they are rich in fancy and imagination; at times even quick and observant; but they swoop headlong to conclusions. Their short-distance memory may be good, but their long-distance memory is nearly always poor. Such children, when they remember things at all, remember them from the meaning or the interest aroused,

rather than from sheer mechanical retention. Facts and dates they speedily forget: general principles and ideas, when they are intelligent enough to grasp them, they can more easily preserve. Above all, they are hopelessly inattentive. Their inability to concentrate, their total lack of industry and application, form the theme of perpetual complaints.

As a consequence, many of these children, if not most, are backward in school work. They are seldom so devoid of intelligence as they seem; some are even bright and precocious: yet the ordinary lessons of the classroom call for precisely those qualities of character and intellect in which they are flagrantly lacking. Almost invariably arithmetic is their worst subject. For drill upon the tables they have no patience, and are far too slapdash to reason out their problems. Anything fresh they eagerly welcome; but to plod day after day at one and the same subject seems to them just vain repetition. In oral work they often sparkle. Their reading may be fluent and dramatically expressive, but full of guesswork and inaccuracies: most of them learn best with 'look-and-say' methods; few have sufficient perseverance for the slow, steady, systematic work that phonic analysis inevitably exacts. Their tongues are always garrulous and glib. They chatter breathlessly to their neighbours, carry on audible or internal colloquies with themselves, and at times confide their sentiments in gushing detail to diaries, letters, or the vacant spaces of a wall.

A diagnosis may often be made from their copy-books alone. The writing is irregular and untidy, inclining to ornamental eccentricities, but never clean or neat. Each page may commence with a laboured, round and upright hand; but soon the letters become jerky and erratic, and gradually trail off into a slanting scrawl, with queer changes of level or inclination where the child has made a fresh spurt or shifted the position of his body or hand. Blots, smudges, erasures, word-omissions are plentiful. Their private letters and notes are frequently in a different hand from their classroom exercises. They are usually scribbled at high speed; but even so it is evident that the pen could hardly keep pace with the thought.

Original and full of invention, their compositions are generally their best productions ; their vocabulary is rich ; their phraseology is sensational and decked out with a superficial smartness ; their spelling is a free improvisation. At informational subjects they sometimes do well ; but the personal element appeals to them far more than the abstract or the inanimate. They prefer history to geography; literature to science.

Their drawings are impressionistic—not without flashes of insight and fancy, but coarse in execution and slovenly in technique. Their handwork—sewing, mending, carpentry, whatever it may be—is nearly always scamped, and often spoilt through want of muscular steadiness and manual control. Yet occasional efforts at design or decoration may show a germ of æsthetic appreciation or an imitative gift. In music and dancing they readily respond to proper training. They love to whistle and sing ; but the jerky rhythm of a ragtime is more to their taste than a smooth tune or subtle harmonies. At every turn they seek to be spectacular, and are nearly always first-rate actors.

The unstable child is not genuinely idle, though frequently accused of idleness. In all that he does he has passing enthusiasms and crazes ; and, where his interest is caught, he will work with feverish zeal in fits and starts. But he readily tires, and is easily diverted by a new subject. Here, as elsewhere, he is the sport of his moods. In after-life, given the requisite intelligence, persons with this temperament may win high prizes in literature or art, and at times even in the field of scientific invention : many earn fame as fanatics. But more often than not they come to grief through lack of perseverance and method. In judgment and common sense they are nearly always wanting, yet at times their practical decisions, though sudden and intuitive, prove surprisingly true to the mark.

The Sensitive and Repressed.—What I have called the repressed type is less easy to diagnose. Too often they are mistaken for apathetic children with little or no emotion at all. Encased in a protective shell, they lie half the time unnoticed and for the rest remain hopelessly misjudged.

Actually their feelings are quite as intense as the feelings of the unrepressed; only they never display them. To the outward observer they look placid and quiet, with faces as inexpressive as a mask; but within they may be simmering with nervous excitement and almost cracking under the strain.

With them the inhibitive instincts preponderate: fear, submissiveness, sorrow, and disgust. As a result all emotion is checked or smothered. They seem solitary, shy, unsociable beings, quickly scared and easily depressed. A watchful eye may sometimes catch them moping or weeping in secret. When spoken to, they just nod or shake the head, or reply in whispered monosyllables. A sudden noise will make them visibly start. Their lips and hands quiver and tremble. Their brows often suggest a mood of everlasting worry by a pained or apprehensive frown. Their mothers are ready with stories of nightmares in the past, how the child would wake up screaming with terror, or become restless or talkative in his sleep whenever things went wrong at school. And they will sum him up, in some stereotyped, figurative phrase, as a 'bundle of nerves,' 'so highly strung,' 'all wires inside like a piano.'

In the classroom, the child who is repressed and retiring fails to assert his presence and is apt to be overlooked. Often he is too timid to answer up in front of others, and in oral work appears far more foolish than he really is.[1] At

[1] A complete and protracted silence is a puzzling feature sometimes met with in such cases. In one instance I was called to examine a backward boy who had not been known to speak a single word since he had entered a new department three weeks before. At his previous school I found he had been nearly but not quite so taciturn: and it was perhaps something more than a coincidence that there his former master, a shy and amiable hermit, was on all social occasions almost as inarticulate as the boy. Indeed, the headmaster quizzically remarked that to set the man to help the boy had been 'like staging a play about the adventures of a couple of deaf-mutes.'

More often, the silence originates in a terror inspired by a hectoring teacher who is anything but noiseless. But the most extraordinary case that has come under my notice was that of a boy of eleven who had always remained speechless both at home and at school so far as any record went back. He was an orphan living with a maiden aunt who was tabetic, psychotic, and nearly stone-deaf. In written subjects, in which alone it was possible to test him, he proved scarcely backward at all. When trans-

written work he may often excel. Yet even here the smallest obstacles may overwhelm him, and he never has the hardihood to explain his difficulties or appeal to his teacher for aid. Rather the sense that he is inferior to his fellows crushes him down, destroying all his initiative, and discouraging every attempt. And so he becomes more backward than ever. Unhappy, over-anxious, yet pathetically eager to please, he comes to abhor and dread his school; and his whole energy is sapped.

Among the backward group in London 8 per cent. of the boys and 10 per cent. of the girls fell into this second category. Just as the excitable and unrepressed cases seemed commoner among the backward boys, so the repressed and sensitive seemed commoner among the backward girls.[1]

Unless there is some neurotic trouble underlying his condition, such a child is far easier to treat and handle than the excitable or unrepressed. A little kindliness and sympathy, a little individual attention, with praise and personal encouragement whenever he grows perplexed, a careful graduation of his tasks so that they are well within his powers, may eventually restore his confidence, and often secure a rapid and remarkable improvement. Over-stimulation may do more harm than good; and constant remonstrances for minor faults are more likely to intensify the child's reserve than to remove it. Where the child has become the butt of his classmates, or where the discipline of the class or department is conducted with a rigid hand of iron, it may prove wiser to look round for a more congenial school.

ferred from home to a private school, and treated on psychotherapeutic lines, he turned out to be all but normal. Extreme examples of this sort, however, are rare and pathological; they are a psychologist's curios, and belong rather to a treatise on children's neuroses.

[1] In Birmingham, particularly among the girls in mixed departments, these cases appeared rather more frequent than in London; in London, while the demonstrative types seem to have increased, the repressed have apparently diminished. These differences it is tempting to connect with the greater freedom and the lessened degree of rigid discipline imposed on the child from without—changes in which, rightly or wrongly, our London teachers sometimes claim to have led the way.

Neurotic Conditions.—In many cases the temperamental instability proved to be the basis or the result of some functional nervous disorder. Among the backward a definite psychoneurosis was diagnosed in 9 per cent. of the cases, and in at least half of them seemed mainly responsible for the child's backwardness. Similar troubles were diagnosed in 4 per cent. of the normal (see Table XXVIII). The neurotic disorders of school children, and their general nature and distribution, I have already discussed elsewhere[1]; here, therefore, I need only touch upon such conditions so far as they occur among the backward and the dull.

Among these the nervous disorder most frequently diagnosed or reported is neurasthenia. It is a label very loosely applied. Where it is correctly used, the cardinal and characteristic symptom is always an excessive liability to fatigue. It appears somewhat commoner among older boys than among girls or younger children. In the group examined here, it was usually found associated with other symptoms of general ill-health, and seemed secondary to some mild physical disorder. Only in a few scattered instances did the neurasthenia prove the sole or primary trouble; and the remainder should perhaps be described as suffering from slight neurasthenic symptoms rather than from neurasthenia in the truer acceptation of the term. Let me give one concrete example,[2] a case which I have already recounted more fully elsewhere.

Willie is an only child of twelve. His face is pale and thin, and he wears a puckered frown across his forehead. There are rings as dark as bruises underneath his eyes; his eyelids droop sleepily; his cheeks and lips hang loose. The muscles of his body, like those of his face, are flabby and slack; and he answers in a low flat voice, devoid of all lively inflection.

When tested and questioned, Willie, like most neurasthenics, proves by no means so dull as he looks. In the classroom he sits with hunched shoulders, irresponsive and

[1] *The Subnormal Mind* (Oxford University Press), Chapters V–VII.

[2] The case is described more fully from a medical standpoint in the volume just cited (pp. 221 *et seq.*).

inert ; yet, when an appropriate appeal is made, his attention is, for a moment or two, quite ready and sharp. Hence, plied with a succession of short conversational tests, like those in the Binet-Simon scale, he answers well enough ; in the performance tests, where he is left to carry on by himself without the constant prodding of the examiner's remarks, he soon comes to a standstill and his energy oozes away. It is plain, however, that his real intelligence, if only he would use it, is quite equal to the normal.

It is in tests of sustained attention that his difficulties come out most clearly. Where the task requires prolonged concentration, kept up by an effort of will, he quickly goes to pieces. With the memory-tests he varies : on the whole, his logical memory seems good, and his mechanical memory distinctly feeble. In reading and composition his attainments are nearly up to the average for his age. But he is a bad speller, and gets hopelessly confused in arithmetic. His writing is a nerveless scrawl, and his manual work clumsy, careless, and ill-finished. He is not without intellectual interests. He wants to be ' an author,' and is genuinely keen to make headway in school work. He cannot be called lazy or indolent, though reproaches of this sort were at one time heaped upon his head. In the classroom he certainly tries his best, and is, in fact, almost morbidly conscientious ; yet, though he takes twice as long over his work as the others, he has only half as much to show for it ; and the effort leaves him visibly exhausted. As his teacher reports, by the end of the day he is ' thoroughly fagged out, ready to drop off to sleep.'

Such cases are by no means uncommon. These are the youngsters of whom teacher and parent alike complain that they seem to have been born tired : they are overcome by the smallest obstacle and prostrated by the least exertion. The wisest treatment is, not to spur them up to fresh endeavours, which may only end in an irreparable collapse, but to leave them plenty of latitude and allow them an abundance of rest, and then to undertake a systematic search for any underlying physical trouble—particularly morbid toxic conditions, whether arising from septic foci,

derangements of digestion or the like, which may exacerbate the natural effects of the toxins of fatigue.

In the younger child anxiety-states are more frequent. These, however, are less likely to retard school progress: on the contrary, they often prove a source of extra effort and even of overwork. They are found chiefly among children of the repressed type. The causes are mixed, and the treatment will vary. Some suffer from a definite emotional complex, which may end in a serious psychoneurosis. Such cases should generally be sent for psychotherapeutic treatment at a clinic. Where this seems impossible or unnecessary, a talk with the child over his worries and difficulties, an explanatory hint to the parents or the class-teacher, and in severe cases rest or removal to the country, will sometimes effect an apparent cure. Mere exclusion from school is often advised by the family physician; but, in the milder stages, lack of intellectual occupation does more harm than good. The child has freer leisure to brood, and may be far more harried by his parents at home than by the teacher in the classroom. Ordinarily it is enough to allow the child to go easily in the more formal subjects. With some, oral work is an added strain. With others, spelling and dictation may become the bane of their lives. With most, however, it is arithmetic that offers the severest trials. They would readily echo the sentiments of Pet Marjorie, the seven-year-old friend of Sir Walter Scott: 'I am now going to tell you the trouble and wretched plague that my multiplication gives me. You can't conceive it. The most Devilish Thing is 8 times 8, and 7 times 7 is what Nature itself can't endure.'

Among the unrepressed, particularly among older girls near the stage of puberty, so-called hysteria is often reported. As a rule, by hysteria the teacher or parent understands little more than what I have described above as constitutional over-excitability. Some of the cases, however, show signs of truly hysterical tendencies. The outstanding symptom of hysteria, as a definite psychoneurosis, is the presence of some apparent physical trouble for which there is no genuine physical cause. Before adolescence is fully developed,

features of this sort are rare. When they appear, the unconscious motive is usually to release the child from lessons that he hates or from daily contact with a master whom he dreads.

A boy of 10, for example, was said to have suffered from hip disease. The diagnosis was admittedly doubtful, and the boy was discharged from the hospital as cured. On returning to school he was promoted to the senior department, which was on the top floor of the building. Five weeks later his symptoms reappeared. As a temporary measure he was permitted to attend the junior department, which was on the ground floor. He rapidly improved; and at the beginning of the next term he was sent back to the senior department, only to relapse once more. This happened on several occasions; and, after the summer holidays, the parents sent an agitated note saying that the boy's leg seemed 'quite paralysed.' The headmaster insisted that the boy should be taken to the hospital. The hospital could find nothing to account for the symptoms, and further reported that, whereas the original trouble had affected the right leg, the boy was now limping with his left, and limping (it was suggested) quite unnecessarily. The headmaster accordingly set the boy down as a wilful malingerer, and referred the case for psychological examination. A first-hand analysis of the boy's mental condition seemed to indicate that the deception was wholly unintentional; but undoubtedly it was calculated to attain the same end as a deliberate pretence, namely, to escape irksome work which was really too hard for his intelligence. By now he was exceedingly backward, and his parents were persuaded to take him to a private school where he received special coaching. Here he made good progress in his work; and no more has been heard of the trouble with the legs.

Hysteria, however, may mimic mental disorders as well as physical; and one of the most singular traits to be met with among backward children of an hysterical type is what is known as 'simulated foolishness.' With careful testing it can be shown that the child has normal or even supernormal ability. Yet he contrives to pass himself off as dull or even mentally defective.

Almost always in the hysterical temperament, especially among the girls, the feature that impresses the lay observer is the child's persistent desire to draw attention to herself—to get (in the teacher's time-honoured phrase) into the lit circle of the limelight and hold the centre of the stage. A child of this type, if she cannot provoke notice by good work, will seek to provoke it by bad.

A common example is that of the girl of 13 or 14 who has won a scholarship to a secondary school. Marjorie, for example, had been for six years the star pupil of the elementary department. Even there she had her fine flashes of badness, and her 'nerves' were known to be 'peculiar.' But these things were tolerated as part of the waywardness that always accompanies genius; and, for the rest, she was humoured, applauded, and held up as a pattern on a pedestal.

She was an attractive child, and knew it. Indeed, her general behaviour was that of a child who saw herself cast for the part of Goldilocks in the nursery rhyme. She easily gained a scholarship. And now in the new school she has to compete with other scholarship-winners who are even brighter than herself. Instead of being at the top of her class she finds herself half-way down among the non-entities. Mortified by the loss of admiration, she reacts by a wanton stupidity; she parades an exaggerated ignorance; and at last has achieved notoriety not as the most brilliant but as the most incompetent of her year. What is more, her electrical temperament has begun to disturb the discipline of the other girls. 'Can you emit sparks?' said the cat to the ugly duckling; and Marjorie, kittenish and catlike in more respects than one, is all sparks and shocks whenever she is rubbed the wrong way. After a wild display, which her mistress considerately reported as 'a kind of nervous breakdown,' she was referred to the school doctor for special examination; and the doctor handed her on to the psychologist as a case of 'pubertal hysteria and general backwardness combined.'

Nearly a dozen examples of this kind can be counted among my notes. What can the psychologist advise? Unless the symptoms are grave, the treatment lies more

with the school than with the doctor. As a rule, once the form-mistress has been brought to understand the problem, she can set herself to win the child's confidence, and, with a little sympathy and tact, soothe the wounded vanity and get the unsettled malcontent to view her new position in a less melodramatic light. When the emotional trouble has been successfully smoothed over, the nervous symptoms may quickly subside, and the backwardness slowly disappear. With Marjorie, for example, these simple measures were entirely effective. In other cases, where the teacher fails, the best plan will be to change the school.

In addition to those who showed clear signs of a definite nervous disorder—neurasthenia, hysteria, or an anxiety neurosis—a large proportion of the backward, nearly one-fifth, showed minor symptoms hardly severe enough to be diagnosed as a psychoneurosis. Such conditions were chiefly found in the children described above as being of an unstable temperament. A surprisingly large number were also noted among the normal. With the normal these milder troubles were more frequent among the girls, whereas with the backward they were commoner among the boys: (compare Table XXVIII). In many cases the symptoms were as much an effect of the child's backwardness as a cause of it; and without a protracted study of each individual case it would be difficult to say how far the neurotic condition had really contributed to the child's slow progress.

The high percentages for functional disturbances among the normal are well worth emphasizing. Such figures point to a most urgent problem that still awaits adequate study and treatment. Among school children, neurotics and potential neurotics are at present almost wholly ignored. It is a problem that I have often stressed in previous writings. Here I need only note that minor psychoneuroses impose a particularly heavy handicap on all intellectual work, dragging the intelligent child down below his possible level of performance, and making the dull child seem duller still. Often overlooked and sometimes unwittingly aggravated by the teacher, such conditions are responsible, not only for poor achievements in the classroom, but also for the acutest misery alike at home and at school.

Temperamental Apathy.—In a few the fundamental instincts and emotions, instead of being too violent, are too weak and inert. These common human instincts, together with the emotions that accompany them, form, in the last resort, the springs of all our mental energy; hence the child in whom such impulses are innately feeble shows little interest in any of the activities of daily life, and seems almost incapable of effort or excitement. His health may be perfect; his nervous condition sound. Yet he sits silent, phlegmatic, and immobile. At times his stolid indifference appears so fixed and imperturbable that his teachers conclude he must be smitten (as one of them puts it in his report) 'with some ineradicable form of constitutional laziness.' He is never offended, never tearful, never alarmed, never amused; he is perfectly content to remain as quiescent as a hibernating frog, doing nothing, saying nothing, and seemingly with nothing in his thoughts.

Genuine cases of extreme temperamental apathy, persisting all through childhood and apparently innate, are far from common. At first sight, no doubt, there are many lethargic youngsters whom the examiner is tempted to relegate to this category. But, on closer investigation, the temperamental dullness proves often to be superficial only. Sometimes it is secondary to dullness of intelligence. Sometimes it is a sequel to physical ill-health or neurotic strain and self-repression. Sometimes it is merely the cumulative outcome of a total lack of mental stimulus and interest in the child's home or school life. One of the most difficult points of diagnosis is to distinguish the child who is really apathetic and unemotional from the sensitive but undemonstrative youngster who is highly emotional within, but does not show his emotions to the outward eye because they are firmly repressed. In London only 4 per cent. of the backward group—nearly all of them, in spite of appearances, quite up to the average for innate intelligence as judged by tests—fell into this category.[1] In general, such cases are best treated along

[1] In Birmingham the proportion was almost double this figure; but owing to the rapid methods of examination in a good many of these cases I suspect that the apathy was only apparent or acquired.

the lines that I shall presently suggest for the so-called 'lazy child.'

Moral Defects.—It is among the temperamental cases that weaknesses of character are most likely to be found. The moral defects to which backwardness is attributed by teachers are mainly two—want of industry and want of honesty. The psychologist, however, regards these traits, not so much as causes, but rather as effects. The essential thing, therefore, is to discover from what the want of industry or honesty arises.

In working through the backward cases which have formed the basis of the present research, I have noted astonishingly few in whom these moral factors played anything but a very subsidiary part. Among other cases, especially those referred to me from secondary schools, such factors often formed the most important element. They are more frequently to be detected among the older children. Perhaps it is only after a succession of years that such tendencies turn into fixed and general habits; and, over and above these cumulative effects, the natural instability, due to approaching puberty, still further upsets the older child's moral balance.

Laziness.—Lack of industry, or, in one word, laziness, is the cause most frequently named by the non-psychological teacher to explain a pupil's lack of progress; and is commonly looked upon and treated as a moral fault. Laziness in the schoolroom, however, springs from various sources: idlers are of very different types. Broadly speaking, five main causes, or groups of causes, may be distinguished: (i) physical ill-health; (ii) intellectual maladjustment; (iii) an apathetic temperament; (iv) an unstable temperament; and (v) some form of neurotic disturbance.

With the child who seems habitually lazy, the first step is to make sure that his health is sound. Lack of mental energy may come from lack of physical energy; and whatever reduces the child's bodily vitality may bring with it, as one of its most conspicuous symptoms, a torpid attitude of mind. Adenoids, as we have seen, are often accompanied by a state of emotional inertia. The catarrhal child is apt to be phlegmatic, metaphorically as well as literally: his

rheumatic condition renders him especially susceptible to physical and mental fatigue, and often sets up an aching in his eyes, head, hands, and limbs, that impedes all active work. Indeed, any form of general ill-health, and almost any specific physical defect, may induce a habit of laziness as the most effective defence against overstrain and discomfort.

In the child who is physically healthy, the cause most frequently discovered is some kind of maladjustment at school. Here it will be important to inquire whether the laziness is a constant feature—whether it is a trait that has been shown in every classroom and in every kind of lesson, or only in certain lessons, or only after the child's promotion to a particular class. The bright child placed in a class too low for him may come to rely solely upon his quick wits, and so fail to develop habits of industry. The dull child placed in a class too high for him may, after a long spell of failure, simply give up trying, in order to avoid the disheartening experience of unsuccessful effort day after day. Among the normal, lack of interest is a frequent factor. One child may be uninterested in school work as such; another child may be uninterested in particular subjects; with a third the teaching-methods or the style of presentation may be quite unsuited to his special interests or talents.

Only in rarer cases does the condition rest on an inherently inactive temperament. The child who is deficient in general emotionality is, as we have seen, automatically deprived of one of the mainsprings of conative energy. From the first moment he comes under notice he shows himself a laggard in all that he does. Among children who are not apathetic but unstable, the laziness is not so much ingrained as a late and secondary acquisition. In a child of the repressed type, the dominance of the depressing instincts—sorrow, fear, disappointed affection—may tend to inhibit all mental exertion, and so make him averse from every kind of work. The introvert and the day-dreamer nearly always get blamed for indolence. Such children seem dull and listless at their lessons because their attention is really preoccupied with their own private fantasies. In

the unrepressed, on the other hand, the predominance of the more aggressive instincts may divert the child's energy into non-scholastic directions. Lively enough in the playground or the street, he will seem slothful and slack in the classroom, where he finds no scope for his adventurous proclivities.

Laziness frequently rests on a mild neurosis. The neurasthenic child, as we have seen, almost inevitably adopts a lazy habit as a protection against excessive fatigue. With those who are suffering from other neurotic tendencies, the conditions at school may sometimes stir up their hostile complexes; and these, dormant hitherto and perhaps wholly unconscious even when active, may in turn prevent the child's full powers from being thrown into his work. At times, quite unwittingly, a particular teacher may revive some ancient and unreasoning feeling of antagonism; so that the child is lazy with that teacher, but industrious with all the rest. Other children are lazy at particular subjects only. The child who has what may be called a mixed inferiority-superiority complex will be disinclined to work strenuously at any task where he finds he cannot show to advantage, because the unsuccessful exhibition hurts his personal pride. If the sense of inferiority predominates, he will feel himself foredoomed to be a failure, and so fall a victim to a kind of moral cowardice. Arithmetic will often inspire these feelings in the older pupils, especially in the girls. Reading is sometimes the bugbear of the younger. 'I know I shall never learn to read, mummy,' declares one small six-year-old, 'so couldn't you tell teacher that she's just wasting her time?' When, on the other hand, the sense of superiority comes uppermost, perhaps as a compensation, the aversion usually spreads more widely, and the youngster carries his nonchalant pose into every classroom of the school.

As a result of these various underlying causes, differing widely in different cases, a child may fail altogether to develop any higher motive which would help him to keep struggling on even when work is disagreeably hard: he acquires no habit or ideal of steady conscientious application, no sentiment (as the psychologist would call it) for

work as a moral duty. He may be bright enough as regards native wits, and vivacious enough in his own amusements ; yet he never troubles to use those wits or to call up his available energy for the harder tasks of the classroom, for he has never formed a practice of working against resistance, and feels no sting of conscience when he knows he is growing slack.

Treatment.—Since laziness differs so much in its origin, it can only be treated effectively by discovering its underlying cause. That must be dealt with first. Anything that saps mental energy must be removed. Or, if mental energy is abundant, and is merely misdirected, then the problem is how to redirect it and make it available for regular work : in such a case the solution is simple and rests almost entirely in the teacher's hands.

In the eyes of most schoolmasters the typically lazy child is the child who can be energetic when he likes, but never cares to be energetic over lessons. In the playground and in the street he will use both mind and muscle ; but in the classroom he is either inactive, or active in the wrong way. He is lazy in the sense that he prefers play to work : at his games he works hard enough, but he will not play the game in school. The cure is obvious. At this stage it is useless to appeal to ideals, to sentiments, to what the teacher calls the child's own conscience. Conscience is not yet sufficiently developed in this direction. We must begin by making school attract him in much the same way as the games that he loves. After all, the distinction between work and play is as arbitrary as it is artificial. From the standpoint of nature, play involves work, and work should be play. From the standpoint of the teacher, work usually means those particular forms of it that the school demands ; and play is mental and physical work undertaken under the stimulus of some native interest or instinct. Accordingly, the teacher must start by identifying the two—by exploiting these native interests and instincts for his own purposes. Introduce the ' play-way ' into the backward classroom, and you may thus be able to harness to your aims all the primitive energy of the various childish emotions. Later you may gradually proceed to build up, little by little, habits of

hard work and dogged perseverance in the face of difficulty and failure. But to reach this stage you must first be content to lead and not drive. Driving will only arouse and reinforce those automatic inhibitions which keep the child's activities at a minimum.

Dishonesty.—Dishonesty is more serious; but here the causes generally seem simpler. In 9 per cent. of my cases the teacher attributed the child's backwardness to persistent dishonesty in the classroom: and always, in the groups here studied, the dishonest child was a boy. But in very few instances in which this cause was cited could I satisfy myself that dishonesty was the sole or even the primary factor. As a rule, it was quite easy to trace the child's dishonest tricks to some prior element in the situation—usually an amount of intelligence or energy inadequate to cope with the tasks imposed. In secondary schools, however, this factor seems more important, and is certainly by no means confined to the male sex.

Dishonesty over lessons may be of varying degrees; and these roughly correspond to the various stages of the defaulter's downward career. The child's disinclination or inability to do the regular work of the classroom may be innocently concealed or deliberately masked by fraudulent devices. He cribs, he copies, or he cheats; he lies over his homework, or forges notes of excuse from his parents. Under an inexperienced teacher he may find these practices so successful that he repeats them again and again, and thus is gradually led on from an occasional prevarication to systematic evasion and deceit; in the end he gives up all idea of applying what ability he has to anything that is the least distasteful. At last he is found out: and the result of years of trickery proves to be a scandalous ignorance of subjects he is supposed to have mastered.

In such cases the teacher is as much to blame as the boy, though the teacher may plead more justification. Indirectly, without the least suspicion of what was going on, he has fostered the underhand habits. He should regard it as part of his duty first to see that the work required lies well within the child's capacity and does not put too great a strain upon his undeveloped powers of hard and steady

work; secondly, he should supervise, closely but unobtrusively, all the child's efforts and all his productions, so as to detect the slightest shirking from the outset. Should the teacher fail, it is only natural that the pupil should come to regard him as an unjust but careless task-master, and eventually to think of him as a natural foe with whom he has to battle by fair means or foul. The master insists on five sums right: and the master cannot see that he is insisting on a miracle. Very well, let him have the correct answers he demands! If the answers are wrong, there will be a shindy; if the answers are right, everybody will be content. What matter how the answers are obtained? Why should the pupil keep on trying, when trying can never lead to success? He may be an idiot at arithmetic, but he is not such an idiot as that. Why then should he be conscientious or industrious, when he will get no credit for his moral probity and only constant censure for a weakness of the intellect which is really not his fault?

Such unspoken arguments may still at times be surmised. But they represent an attitude far less prevalent to-day than in previous generations. Little by little the traditional warfare between master and pupil has begun to die down. 'My schoolmaster,' says Samuel Johnson, 'never had to teach. He whipped; and the boys learned.' Nowadays, disciplinary punishment is mainly reserved for grave lapses of behaviour, and is seldom meted out for intellectual failings. More and more, pupils have come to accept their masters not as enemies but as friends; and few will cynically deceive a man whom they respect, admire, and have even learnt to love.

Accordingly, in the school of to-day, the methods of concealment prove, as a general rule, to be more or less unintentional: it is only in rare instances and by fairly slow degrees that a lad takes to the practice of premeditated fraud. Children, even the most virtuous, have an extraordinary knack of hiding their deficiencies in one direction by some talent or aptitude in another. A boy whose ready memory makes up for his poor intelligence may, without ever meaning to mislead, give his teachers the impression that he is much sharper than he really is, and that he

comprehends completely what he only knows by rote. In the old days when classes were large, when requirements were rigidly strict, and when the main thing demanded was an outward semblance of efficiency, it was possible for many dullards to pass muster in this way. As he grew older the child became clearly conscious of the tactics he was adopting and of their temporary success; then, sooner or later, in sheer self-defence, he was driven to eke out an innocent disguise by deliberately planned deceit.

With others the dishonesty is an indirect rather than a direct outcome of the situation in the school; and the first lapse takes place outside the classroom instead of inside. At school the dull child feels a hopeless failure. His life there may be one humiliating round of rebuke, disgrace, and punishment. He soon comes to dread the daily journey. He is tempted to play truant. Truancy brings freedom, and opportunities for enjoyable mischief; and so little by little he drifts into crime.

Of my backward group in London, 5 per cent. had occasionally played truant, and 4 per cent. were known to have committed definite delinquencies, for the most part petty pilfering.[1] In the control groups, whether in Birmingham or London, no single case of serious delinquency was brought to my notice. In my study of juvenile delinquency I found that nearly 30 per cent. of the delinquents were definitely dull, and nearly 60 per cent. were backward in educational attainments.[2]

Treatment.—The treatment both of the unstable and of the dishonest is as much a problem of discipline as of teaching-methods. This I shall discuss when I come to describe the general organization of the backward class. Here I need only say that the nature and degree of discipline

[1] The cases of character defect found in the Birmingham survey gave much the same figure, namely, 5·6 per cent. This percentage, however, included one or two instances where the child's conduct hardly amounted to delinquency, but where, nevertheless, his backwardness seemed definitely due to a defect of character in the broader sense, for example, to persistent truancy or stubbornness in school. On the other hand, the absence of any thorough investigation in the home doubtless prevented many cases of petty crime coming to light in that survey.

[2] *The Young Delinquent*, p. 294.

must always be adapted to the individual case, and this will rarely be possible without a special study of the individual and his motives.

Delinquency and neurosis are urgent and complex problems which call for special study in themselves. Except where the backwardness is itself the cause of the delinquent or neurotic tendencies, a child who is delinquent or neurotic as well as backward must be treated primarily for his nervous or moral weaknesses rather than for his backwardness: so long as the former persist, no amount of coaching is likely to remove the latter. How such cases may be best studied and handled I have already discussed at some length in previous volumes: here, therefore, I need say no more.[1]

[1] See *The Young Delinquent*, esp. pp. 516 *et seq.*, and *The Subnormal Mind*, esp. pp. 191–342. As this ends my review of the personality of the child, a word may be needed on more recent suggestions for classifying children according to their character-traits. In this country various alternatives have been adopted by psychiatrists at child guidance clinics, based on suggestive speculation rather than on careful research. The commonest may be reduced to two broad groups—behaviourist (or materialist) and psychoanalytic (or mentalist). Psychiatrists with mentalist leanings base their classification of normal children on that of the abnormal adult (with whom they are more familiar): six or seven temperamental types are usually specified—*e.g.* schizoid (' shut in '), cycloid (' alternating moods '), hypermanic (' active, aggressive '), depressive (' anxious, depressed '), paranoid (' jealous, quarrelsome '), hysteroid (' selfish, criminal '), epileptoid, etc. The materialists, on the other hand, would eliminate all reference to mental states or innate tendencies, and express behaviour in terms of observable bodily reactions; and so we have glandular, autonomic, or physical types. A glance at the recent periodical literature, however, is sufficient to show that, even in its home of origin, materialistic behaviourism is now obsolescent. The ' purposive behaviourists,' like Tolman and his followers, the ' experimental psychoanalysts,' like Murray and his fellow-workers, have been led to working schemes much the same as those outlined here (though expressed in different language), and now accept what they own to be very like McDougall's list of instincts. Psychologists in both countries have sought to analyse the more important tendencies and types by factorial methods; and there is now far more agreement than when this book first appeared. On the validity of the different methods used for assessing personality in school children, compared in the light of follow-up results, see Burt, ' Assessment of Personality,' *Brit. J. Educ. Psych.*, XV, pp. 107 *et seq.*

CHAPTER XVI

SUMMARY AND PRACTICAL CONCLUSIONS

Multiplicity and Variety of Causes.—We have now reviewed all the discoverable conditions that could conceivably be connected with the educational backwardness of the children we have chosen for study. Having collected and analysed our data, we are in a position to attempt a final answer to our main theoretical problem: how is backwardness caused?

Throughout the whole inquiry one outstanding conclusion emerges again and again—the fact of *multiple determination.* The causes of backwardness prove unexpectedly numerous and varied; and in most cases not one cause, but several, are at work. If we count the child's whole physical condition as a single factor only, even when manifesting itself by several symptoms or defects, then we may say that, *on an average, each backward child suffers from at least three adverse factors* tending to retard his progress at school. Were we to reckon up all the different factors that have been separately specified in the foregoing tables (not, perhaps, a strictly defensible proceeding), we should find that more than sixty distinguishable conditions had been reported or observed. When we try to sort them out, according to their general nature, we are met with a wide variety: some are physical and others mental; some are to be found within the child, others in the circumstances in which he lives or has grown up; some appear to have been inherited or at any rate to form part of the child's congenital endowment, others are social or environmental; and of these latter some arise inside the school, others arise outside it. Thus, from one individual to another, the character of the essential causes and of their changing combinations differs greatly; and backward children, it is amply clear, are far from constituting a homogeneous group.

Comparison of Frequencies.—Certain causes, however, are

doubtless more powerful and more prevalent than others. But to determine which are, in fact, the most important is a somewhat intricate task. We may, perhaps, begin by noting what conditions throughout the whole investigation have been most frequently observed.

In the last columns of Tables XXIX and XXX, I have endeavoured to give a final epitome of the statistical results. The different conditions have been grouped under the most natural headings; and the figures in the last column show how many backward children were reported as having made bad attendance, or as having been badly taught, or as having suffered from particular forms of social, physical, or psychological disabilities.[1] Taking the figures for the London group and looking first at the broader classification, it appears that three-quarters of the children (or rather more) were found to be suffering from unfavourable *physical* conditions; two-thirds (or rather less) from unfavourable *social* conditions; three-quarters from unfavourable *intellectual* conditions; about one-third from unfavourable *temperamental* conditions; and only one-sixth from unfavourable *school* conditions.[2]

[1] The figures in the line marked 'subtotal' show the total number of children falling under the more general heading; this is usually smaller than the actual total of the figures in the column above, which would, of course, give not the number of children, but the number of times the conditions had been observed.

[2] If we take the figures for the Birmingham group, the proportions may seem at first sight a little divergent. But at Birmingham, it must be remembered, the investigation was not sufficiently prolonged for a complete inquiry into home conditions and temperamental peculiarities to be made. By making due allowance for these, the two inquiries, with one exception, can readily be harmonized. The exception consists in the widely different figures for irregular attendance discovered in London and in Birmingham respectively during the period of our survey. This difference serves as a salutary reminder that in different areas, and even at different periods in the same area, backwardness may constitute a different problem. For example, the fact that inefficiency of teaching accounts for comparatively few cases in the two cities covered by my survey does not mean that elsewhere a different conclusion might not be inferred; or again, although in the large industrial cities backwardness appears closely related to economic and hygienic conditions, it is conceivable that in residential towns or in rural districts another picture might be drawn. We need, in fact, a general review of the

[*Continued on p.* 568.

TABLE XXIX. SUMMARY OF CONDITIONS (LONDON)

Percentage of Backward Cases showing the Conditions Specified

	Major.	Minor.	Total.
I. Inherited Conditions (conditions reported in family histories)			
1. Physical	3·1	16·1	19·2
2. Intellectual (General) . .	31·2	2·3	33·5
3. Intellectual (Specific) . .	5·4	3·3	8·7
4. Temperamental . . .	7·2	13·0	20·2
Total .	46·9	31·7 [2]	78·6 [2]
II. Environmental Conditions			
A. School Conditions			
1. Irregular Attendance . .	6·7	4·9	11·5
2. Inefficient Teaching . . .	0·8	1·8	2·6
3. Inefficient Organization . .	1·3	3·8	5·1
Subtotal .	8·8	7·7 [2]	16·5 [2]
B. Social Conditions			
1. Material	8·4	50·7	59·1
2. Intellectual	3·1	12·5	15·6
3. Moral or Emotional . . .	1·3	9·5	10·8
Subtotal .	12·8	51·1 [2]	63·9 [2]
Total .	21·6	52·3 [2]	73·9 [2]
III. Physical Conditions			
A. Developmental	1·0	7·7	8·7
B. Pathological			
1. General	4·1	63·2	67·3
2. Specific	5·4	57·0	62·4
Subtotal .	9·5	63·6 [2]	73·1 [2]
Total .	10·5	69·3 [2]	79·8 [2]
IV. Psychological Conditions			
A. Intellectual			
1. General	53·2	6·9	60·1
2. Specific	5·4	12·0	17·4
Subtotal .	58·6	18·9	77·5
B. Temperamental			
1. Emotional	7·2	25·8	33·0
2. Moral	2·1	7·4	9·5
Subtotal .	9·3	25·8 [2]	35·0 [2]
Total .	67·9	28·0 [2]	95·9 [2]
Grand Total .	100·0 [1]	100·0 [2]	100·0 [2]

[1] Excluding 'inherited' conditions.

[2] Excluding observations overlapping in the same child.

TABLE XXX. SUMMARY OF CONDITIONS (BIRMINGHAM)

Percentage of Backward Cases showing the Conditions Specified

	Major.	Minor.	Total.
I. Inherited Conditions (conditions reported in family histories)			
1. Physical	4·6	2·0	6·6
2. Intellectual (General)	21·4	8·2	29·6
3. Intellectual (Specific)	2·6	1·5	4·1
4. Temperamental	5·1	3·6	8·7
Total	33·7	15·3	49·0
II. Environmental Conditions			
A. School Conditions			
1. Irregular Attendance	8·2	23·0	31·2
2. Inefficient Teaching	1·0	3·6	4·6
3. Inefficient Organization	1·5	5·6	7·1
Subtotal	10·7	24·0 [2]	34·7 [2]
B. Social Conditions			
1. Material	6·6	17·9	24·5
2. Intellectual	4·1	13·8	17·9
3. Moral or Emotional	1·0	2·1	3·1
Subtotal	11·7	27·6 [2]	39·3 [2]
Total	22·4	36·8 [2]	59·2 [2]
III. Physical Conditions			
A. Developmental	2·6	10·2	12·8
B. Pathological			
1. General	7·7	53·5	61·2
2. Specific	6·1	52·8	58·9
Subtotal	13·8	49·0 [2]	62·8 [2]
Total	16·4	59·2 [2]	75·6 [2]
IV. Psychological Conditions			
A. Intellectual			
1. General	45·4	15·8	61·2
2. Specific	9·2	12·2	21·4
Subtotal	54·6	28·0	82·6
B. Temperamental			
1. Emotional	5·1	13·3	18·4
2. Moral	1·5	4·1	5·6
Subtotal	6·6	17·4	24·0
Total	61·2	32·7 [2]	93·9 [2]
Grand Total	100·0 [1]	100·0 [2]	100·0 [2]

[1] Excluding 'inherited' conditions.
[2] Excluding observations overlapping in the same child.

If we look next at the more specific conditions and pick out those that recur most often, we may say that their relative frequency is as follows: first, minor defects of general health—the most numerous of all; next, defects of sight, hearing, and speech—almost as numerous, though only one-third were actually severe; thirdly, dullness of general intelligence; and then, in diminishing numbers, material poverty in the home, emotional instability, special intellectual defects, low intellectual culture in the home, and irregular attendance at school—roughly in that order.

Comparison of Correlations.—The bare frequencies, however, do not tell us much. As a matter of fact, the order just indicated is approximately the order of frequency with which we find such conditions occurring in any batch of elementary school children, backward or normal. Hence these recurring conditions cannot be forthwith set down as active causes of backwardness in whatever child they are found. The coefficients of correlation afford a somewhat better guide.

The highest correlation that we have encountered is that between educational attainments and general intelligence (about ·7). When the influence of intelligence is ruled out, the correlations between backwardness and weakness in certain specific intellectual capacities (reasoning, memory, attention, and the like) appear comparatively small, though long-distance memory still shows a fairly high correlation (·5 to ·6). The next most important factor, judged on this basis, would seem to be irregular attendance (·45 at London, ·58 at Birmingham). Then come certain specific defects such as poor hearing and impediments in speech—conditions that are somewhat rarer in their occurrence, but gravely detrimental when well marked (about ·4, if we average the results of the two investigations). Backward development in general physique also shows a well marked correlation (about ·3). Extreme poverty yields a correlation nearly as large, though not, perhaps, so large as might have been anticipated: much evidently depends on the degree to

whole problem throughout the country similar to that recently undertaken by the Board of Education, in conjunction with the Board of Control, into the problem of mental deficiency.

which the school can compensate for the shortcomings of the home (·25 to ·30). Then follow a number of defective physical conditions usually accompanied by general weakness and ill-health—adenoids, malnutrition (marked or constitutional), rickets, a succession of infectious diseases, recurrent catarrh, and the like (·20 to ·25). Certain conditions associated with a nervous temperament may at times be almost as detrimental (general excitability, anxiety states, chorea, neurasthenia, and the like, with coefficients in the neighbourhood of ·20). Finally, visual defects show a small positive correlation, just above the level of statistical significance (averaging about ·15). Other conditions which no doubt in individual cases may form active and important causes—rheumatism, and malnutrition due to social conditions, for example—yield correlations which are too small to be significant with groups of the size here studied.

Deduced, as they are for the most part, from coarsely graded data whose exact distribution is unknown, calculated, too, by methods that are not always strictly comparable with one another, these coefficients cannot provide more than a broad preliminary indication of the relative influence of the different factors. Indeed, a condition that is exceedingly rare, even in the backward, may nevertheless show a high correlation with backwardness, because it is almost non-existent in the normal. Moreover, the mere fact that a certain condition is correlated with backwardness does not prove that the condition was an effective cause.

Major Factors.—Let us, therefore, attempt a slightly different line of approach. Although in most cases of backwardness there are, as we have seen, several adverse conditions observable, nevertheless it is often possible, on watching each child's subsequent history, to decide that one of these factors has after all been more important than the rest. Accordingly, after reviewing all the records available for every child, I have endeavoured wherever possible to pick out the particular factor that seemed the most influential in each case. This I have counted as the major factor: the rest I have regarded as secondary or accessory conditions. Where two or more factors seemed

of equal importance, or where no evidence for such a distinction was available, I have divided the figures in equal proportions. I have attempted this form of analysis both for the Birmingham and for the London groups. With the Birmingham children the decision was based mainly on discussions with the teacher; at London, where each child could be followed up for several terms or years, I have based it mainly on a first-hand study of the child's subsequent progress under remedial measures.

The figures thus reached are shown in the first column of Tables XXIX and XXX under the heading 'major condition.' Rough as it is, the analysis throws a new and suggestive light on the relative importance of the various sets of causes. Judged by its influence, as well as by its frequency, it still appears that by far the most important cause of all is a dull intelligence. If a child is well below the average in general intelligence, that alone may be enough to form a fatal hindrance to the attainment of an acceptable level in school work. At London more than half the cases owed their backwardness predominantly to this cause; and I imagine that the number would have risen to much the same proportion at Birmingham had the inquiry been prolonged. In a large number of these cases there was reason to believe that the child's poor intelligence was not only innate, but inherited.[1] School conditions,

[1] In the Table, the phrase 'inherited conditions' must not be taken as necessarily denoting anything more than 'relevant conditions noted in the family history' or 'conditions observed in one or more members of the family as well as in the child himself.' If we consider major causes only (first column), it will be seen that conditions apparently inherited are more than twice as common as those recorded as environmental. On the other hand, if we look merely at the total number of times the various conditions were observed, or the total number of children showing such conditions, whether their influence was primary or secondary, there is little difference between the two sets of percentages (last column). But the classification of conditions into 'inherited' and 'environmental' has no great scientific value: first of all, the data given by the family histories is hardly likely to be complete; and, secondly, there is no criterion whereby we can say whether a given condition, appearing not only in the child investigated but also in other members of the family, is hereditary as such. At most, therefore, it can only be claimed that these figures provide strong *prima facie* evidence that the major causes are more often hereditary than environmental.

social conditions, physical conditions, temperamental peculiarities, and specific intellectual disabilities, prove each of them to be major factors in about one-tenth of the cases—sometimes a little more, sometimes distinctly less. Of these the conditions most frequently noted as of major importance are social—including under this term the intellectual and moral status of the home as well as sheer poverty; physical conditions follow next[1]; school conditions, temperamental peculiarities, and special intellectual disabilities seem the least frequent of all.

There can be little question that *the chief reasons for educational backwardness are psychological.* In some cases no other factor worth considering was discovered; in others, and these form the majority, the child's inherent dullness was aggravated by social or physical disadvantages, the social and the physical factors often going hand in hand and proving almost inseparable. As the figures for the control group clearly show, with normal intelligence a child may surmount these physical or social obstacles sufficiently to hold his own at school; his work may not, perhaps, rise to the full level of his capacities; but he will not become definitely backward. The child labouring under a double load—penalized by inner as well as by outer handicaps—drops almost inevitably below the borderline.

As regards physical factors, it should be noted that, in general, whether they constitute the main or merely a subordinate cause, it is seldom easy to distinguish their influence from that of other factors. Sometimes the poverty-stricken conditions under which the child has been brought up seem directly responsible for his bodily ill-health. In other cases, his dull mentality and delicate physique appear to be the common effects of some innate constitutional weakness—a weakness which may very possibly characterize his parents as well and so be accountable for the poverty in which the whole family is living.

[1] At Birmingham the figures for social conditions are undoubtedly too low, since, as we have seen, no thorough first-hand investigation was undertaken of the children's home life. On the other hand, it is possible that a good many cases were attributed to physical conditions which a further investigation would have shown were due to other factors, probably social or temperamental.

Were we required to attempt a distinction between psychological and non-psychological types of backwardness —that is, those in which the causes are mainly or solely mental and those in which they are mainly physical or social or scholastic—it is clear that the former would be far more numerous ; nearly 70 per cent. of the cases would fall under the former heading, leaving 30 per cent. or a little more under the latter. These various methods of analysis, therefore, though not altogether beyond criticism when each is taken by itself, point consistently to the same conclusion. From the standpoint of causation, backwardness is to be regarded far more as a psychological problem than as a medical problem ; it is due, more often than not, primarily to intellectual or temperamental disabilities, and only secondarily to ill-health or bodily disease. In only 10 per cent. of the cases at London, and 16 per cent. at Birmingham, were the causes predominantly physical.

From the standpoint of treatment and future outlook, it may be instructive to make the division at a slightly different point. In how many cases, the teacher and educationist will ask, is the backwardness likely to be permanent and hopeless, and in how many can it be corrected by social, medical, or educational measures ? As we have already seen, it is possible to make some rough distinction between those who are 'merely backward' and those who are inherently or irremediably handicapped by some permanent disability, whether physical or mental, the latter consisting largely, but not exclusively, of those who are innately 'dull.' On going through the case-histories once again, it appears that both at London and at Birmingham between 60 and 70 per cent. belong to the latter category, and the remainder to the former. *In the majority the outstanding cause is a general inferiority of intellectual capacity, presumably inborn and frequently hereditary.*[1]

[1] Dr. Lloyd's conclusion, arrived at independently and in entire ignorance of my psychological data and inferences, seems to be in close agreement with my own. He found that in 54 per cent. of the cases some innate psychological defect was strongly to be suspected ; and in 25 per cent. physical defects were a prominent feature ; among these latter, physical defect seemed the only discoverable factor in 5 per cent. of the cases, while in the remaining

Treatment.—Although for theoretical purposes, where we deal with large groups and where the case-histories have been followed up for some years, it may be legitimate to sort the children into categories or classes, yet in practical work, where we deal with single individuals, and are often required to offer a tentative prognosis at the very outset, the endeavour to assign each case to one of two or three mutually exclusive types will always be precarious, however the dividing lines be drawn. In most instances, as we have seen, the causation is pretty sure to be complex; and in the early stages it is often difficult to guess which (if any) of the conditions discovered is the major or crucial factor. The typical case, if there is one, might perhaps best be summed up as follows. Some physical abnormality, or more usually a group of physical abnormalities, impinges upon a mentality which is itself, from the very outset, weak, and weakens it still further; and both the weak mentality and the physical drawbacks are intimately associated with the inferior stock and the adverse environmental conditions that are found most commonly in the poorer homes. In every instance, therefore, a systematic inquiry should be undertaken in all directions, physical, social, scholastic, and psychological; nor should any adverse factor be neglected on the ground that its influence is only minor or contributory. Even when a secondary condition has not actually created the backwardness, it may nevertheless seriously impede its treatment or removal.

Indeed, when we turn to consider what steps are immediately practicable, the importance of the various conditions

20 per cent. some handicap arising from the child's home circumstances, school history, or specific difficulties with school work, was contributory. With the rest the causation was, in his view, not clear, and most probably of a mixed and varying character (*Report*, *loc. cit.*, p. 27). My own classification of the Birmingham cases was made at a somewhat later stage in the inquiry, and has been to some slight extent readjusted since. Very often the teachers were good enough to report the subsequent progress of the children examined, and in not a few cases further factors came to light. For example, in many instances a physical defect, considered at first to be an essential cause, was successfully treated and the child still remained backward until some further measure was carried out, *e.g.* a change of class, of teacher, or of home surroundings. Thus the whole of our experience tends to show that it may be extremely unsafe to decide off-hand that some conspicuous physical disability is the primary cause of a child's backwardness.

is often altered or reversed. Apart from attempts at eugenic restrictions, the inherent mental incapacity of the population can—in the present state of knowledge—be little, if at all, alleviated ; but the bodily disabilities, the social handicaps, and the defects in educational arrangements, may, in some degree at any rate, be successfully attacked. For the rest, what the child lacks in inborn mental ability may be partly compensated by increasing his acquired attainments through more appropriate methods of organization and teaching within the school. In the whole field of education no measure is more urgently needed at the present moment than that of special provision for the backward child. The question accordingly arises, in view of the facts thus ascertained, what are the best forms for this special provision to take? [1]

Segregation.—The first and most important step is segregation, the formation of separate classes or schools expressly for the educationally subnormal. Segregation sounds a drastic measure ; yet it is needed in the interests alike of the other children, of the teachers, and of the backward themselves.

At present, what is happening ? The backward child has to be taught either with those who are much more advanced than he, or else with those who are much younger. If he is placed in a standard corresponding with his actual age, he is

[1] Many of the suggestions, developed in the following paragraphs, were originally drawn up, in brief and summary form, for my Report to the L.C.C. on Provision for Backward Children (reprinted as *Development Memorandum No.* 1, to be obtained from the Council's publishers, P. S. King & Son, Ltd., Great Smith Street), and have since been partly incorporated in the Board of Education's *Handbook of Suggestions for Teachers* (H.M. Stationery Office, 1927, pp. 422 *et seq.*). I am indebted to the authorities for permission to embody and expand in what follows the proposals there put forward. Both in formulating my original recommendations, and in revising them for inclusion here, I am under a special obligation to numerous teachers of experience who have discussed with me the problems raised, have allowed me to study their own organization and methods, and have always been willing to experiment on the merits of various notions, some perhaps of value, others often worthless, which from time to time I have wished to see worked out. In particular I am indebted to one of my own research students, Dr. G. F. Sleight, who carried out a systematic survey of the various attempts hitherto made to deal with backward children in London schools and (on a briefer scale) elsewhere.

bound to find the work too difficult, and will quickly come to hate or worry over it. The teacher and the rest of the class go too fast for him. He becomes a drag on all, and may soon be looked upon as a hopeless dunce, doomed to perpetual failure, and in everlasting disgrace. If, to avoid this fate, he is sent back to a standard which corresponds more with his actual attainments than with his age, then he finds himself in the midst of youngsters whom he scorns as 'mere kids' beneath his general level: the babyish books, the babyish methods, the babyish tone of the classroom, he will at once resent. He will try to recover a sense of superiority by professing a contempt for the work in which he fails; and, if he is as old in mischief as he is in years, he will probably revel in leading the younger ones astray. At the same time, the other members of the class, being quicker and cleverer than he, will continually outstrip him. And there he will remain, at the bottom of the school, while group after group is promoted over his head. What can be more damaging to his self-respect?

If he is to develop to the full limit of his own meagre powers, the backward child must have a special curriculum, a special time-table, and special teaching methods adapted to his narrower mind. These he can scarcely receive in the ordinary classroom. Further, the backward differ so much from one another that each has to be treated as a problem in himself. With a relatively homogeneous class, consisting exclusively of average pupils, collective teaching may work well enough; and with the bright or supernormal what is needed is not so much individual attention as opportunity for individual work. But with the backward the first essential is personal care and study concentrated separately on each particular child. Separate provision, therefore, is urgently needed in the interests of the backward themselves.

Secondly, it is equally imperative, in the interests of the normal child, that all the members of a class should be able to advance together. Under collective methods of teaching, the progress of a class at work, like the progress of a column on the march, can be no faster than the speed of its slowest unit; and it is better that the lame and the limping should fall out than that the whole regiment should mark

time while the laggards catch up. And, thirdly, some kind of sorting out is requisite in the interests of the teacher. If, within the ordinary classroom, he tries to adapt his work, not only to the needs of the normal majority, but also to the needs of the backward few, he is really doing double duty: it is like asking a single shoemaker not only to manufacture the boots and shoes for the neighbourhood, but at the same time to take charge of all the repairs. Inevitably, the harassed teacher becomes torn between two competing demands; the worry, the strain, and the distraction that he feels, are bound to react adversely on both the normal and the duller pupils. The normal will be kept back, and the backward become more backward still.

Segregation, therefore, seems essential. It may take two main forms: the establishment of special or auxiliary schools, and the formation of backward or auxiliary classes within the ordinary schools. The designation for such schools or classes should be chosen with care, to avoid any reluctance on the part of children, parents, or teachers.[1] The new class might be called the 'practical class,' the 'industrial class,' 'class 6c,' or even (as in one department I am familar with) 'standard Ex VII'—anything but the 'backward class' or 'standard o.'

(*a*) *Special Schools for the Educationally Subnormal.*— What, then, are the types of special school most urgently needed and what kinds of children are suitable for transference to such places? No simple or uniform rule can be laid down for the country as a whole. Obviously in rural or in sparsely populated districts the kind of provision that is possible will differ widely from what is practicable or

[1] As noted above (p. 88), the phrase 'educationally subnormal' has already led to a certain amount of misunderstanding among the general public and even of opposition from parents whose children have been 'ascertained.' Such misinterpretations do not necessarily constitute a reason for altering the official terminology; nevertheless, even when a school may have been formally classified as a 'Special E.S.N. School' for administrative purposes, it might well receive an individual name for everyday use. A similar policy has frequently been found helpful in combating the prejudice against the 'secondary modern schools': and it might go far towards preventing the new type of special school from inheriting the popular nickname of its predecessor, and becoming known among resentful parents as the 'silly school.'

desirable in the more populous towns or industrialized areas.

Most psychologists, alike in Britain and abroad, would agree that, in view of their unusual needs and characteristics, those children whose intelligence quotients fall below 70 undoubtedly need a different type of teaching from that given to the merely dull or backward whose I.Q.'s are between 70 and 85. And to be effective this type of teaching must be given in a separate school, where the classes are small and suitably equipped, and where the teachers themselves have been appropriately trained. Indeed, as we saw at the outset of our discussion (pp. 79 f.), this 'marked difference in mentality' (as Professor Nunn once described it) forms the main reason why a borderline of 70 or thereabouts was commonly adopted for transferring pupils to a special school of the pre-war type. In the course of the last fifty years, a large amount of practical experience has been gained in regard to the intellectual and temperamental peculiarities of these children and the most effective ways of dealing with them; and there is a general agreement about the kind of curricula and teaching methods suitable for such cases.[3] The fact that the official designation of this group has been altered and the mode of transference changed does not in any way affect the practical conclusions already reached. On the other hand, far less is known, and little has as yet been published, regarding the instruction of the merely dull or backward. Research on the relative efficacy of the different methods of teaching pupils of these higher grades is comparatively new; and for that reason I have mainly concentrated on these more numerous types in this particular volume.

Nevertheless, it manifestly follows from what I have said that the most urgent measure is the provision, wherever possible, of E.S.N. schools for the lowest 1 or 2 per cent. of the educable population. At the moment the available accommodation is barely one-quarter of what is actually needed; and, although certification has been abolished, the process of transferring a child to a special E.S.N. school is still somewhat cumbersome. Numerous safeguards have been introduced, which involve formal ascertainment, permission to appeal, re-examination, and the like. Here a

general principle, applicable in almost every type of area, can be safely laid down: wherever one or more special schools have been established, priority should be given to those children whose handicaps are most severe and most likely to be permanent. At present the initiative is left to the head teachers, whose standards and criteria are apt to differ considerably from school to school even within the same area. As a result the pupils most likely to be put forward seem to be those who have proved themselves most troublesome in the ordinary classroom. That may be a sound reason for changing the child's teacher, class, or school; but it is not the primary ground for transference to a special school. As Dr. Cleugh has rightly observed, 'the strongest claim on places in the E.S.N. school remains with those whose innate handicap is greatest, and who are therefore most likely to stay in the special school during the whole of their school life; . . . in the last resort the I.Q. is probably the crucial criterion.' [1]

One or two authorities have experimented with an alternative scheme. Acting on instructions from the head officer, the educational psychologist pays an annual visit to all the junior schools in turn, and makes a preliminary survey of the younger age-groups. After due consultation with the teachers concerned, the most backward are then referred for a more intensive examination at the head office, and the parent is invited to attend. This helps to even out the differences of standard. But, no matter what procedure is eventually adopted, the one thing really necessary, before a child is officially 'ascertained,' is a full and systematic inquiry into the reasons for his difficulties and the apparent causes of his educational retardation.[2]

On psychological grounds I am inclined to suggest that the type of E.S.N. school most widely needed at the present

[1] M. F. Cleugh, *loc. cit. inf.*, pp. 20, 38.

[2] The whole problem has been admirably discussed by Dr. Cleugh in her recent book (*The Slow Learner: Educational Principles and Policies*, Methuen, 1957)—a book which every teacher and education official should study. Basing her account on up-to-date and first-hand information, she has described in detail the commoner schemes at present adopted by different authorities, and has compared their merits and their limitations in the light of what is practicable and what is really needed in areas of different types.

time is the school which caters for both sexes and all ages. On administrative grounds no doubt it may be both possible and wise to depart from this general policy in certain areas, particularly in the larger and more populous towns. That, however, is a point of detail which I shall discuss more fully when we turn to consider the needs of different ages. The majority of authorities will seldom be able to provide more than a single E.S.N. school; and many educationists have therefore argued that the most pressing need at the moment is to make special provision for the older age-groups. The sharp division now commonly drawn between primary and secondary schools with a sudden break at 11+ is largely responsible for this point of view; and certainly the reorganization of schools on this two-storey basis has brought with it many new problems. At the chronological age of 11 the retarded child, just because he is retarded, will not yet have reached the mental or the educational level of an average child of 11. Hence it seems a little illogical to suppose that the 'clean cut at 11+' must apply equally to the normal and to the subnormal. Under the old régime, departments for infants, boys, and girls were commonly housed in the same building, and the latter included pupils of every age from 7 to 14. Thus the older child who was backward in school work could be relegated to a lower 'standard'; and there was nearly always someone on the premises who could give advice on the teaching of the essential rudiments—especially the teaching of the backward readers. Today a large secondary modern school nearly always contains a number of educationally subnormal pupils, whose level is that of the primary child rather than of the secondary, and whose needs depart widely from those of the normal child of 11 or more. Male teachers in such schools are especially apt to be baffled when wondering how to cope with cases of reading disability, which, as we have seen, are particularly rife among the duller boys; and, whether organized for boys or girls, few secondary modern schools are at present equipped with the special apparatus, the special materials, and the specially trained teachers that are needed for the concrete and practical type of teaching that the older subnormal child requires. Accordingly, some

of the larger urban authorities have been led to institute two types of E.S.N. school—primary and secondary, with a break at the usual age of 11+.[3]

This in my view is rarely advisable. Continuity of teachers and of teaching methods, together with a stable school environment, are of particular importance for the dull and backward. If they have been ascertained and removed to a primary or junior E.S.N. school, they will already have suffered a further break in addition to those experienced by the ordinary child ; and to impose a fresh interruption at 11+ will be as harmful as it is unnecessary.

In any case, there are manifest drawbacks, psychological as well as administrative, in the attempt to solve the problem mainly by providing special schools. The older child, marked out for a different type of education, is especially apt to suffer from an increasing awareness that he is regarded as different from other pupils. The long journeys to and from the only special school in the area prove extremely fatiguing to those whose prime need is to conserve their strength and energy for work in the classroom. And therefore, particularly for milder and remediable cases, some alternative solution is desirable.

(*b*) *Special Classes for the Backward.*—Evidently in areas where it is impossible to collect sufficient children to form an entire school, special classes will have to be organized within the ordinary department. And, wherever a backward school is out of the question, the establishment of such a class will prove not only a practicable but also an economical plan. The children may be admitted to such a class (i) from one department only, (ii) from two or more departments—boys', girls', and even infants'—within the same school, (iii) from several schools grouped together for the purpose, thus forming a 'centralized class,' as it might be called. In the infants' department the backward children will, as a rule,[1] best be catered for along the lines now adopted in all progressive infants' schools, without segrega-

[3] According to the latest information available (*Education in 1955*, H.M.S.O., 1956, Table 45), there are about 142 all-age E.S.N. schools, 40 primary, and 74 secondary. The commonest plan is a single all-age day school catering for the whole area so far as transport facilities allow.

tion into special classes. With junior children from 7 to 11 there is little objection to mixing the sexes for teaching. At a later age, however, children of the kind we are considering are often unstable as well as dull, physically precocious though mentally immature; in worldly knowledge they may be as advanced as they are backward in school progress: and experience shows that it is often far from prudent, especially in the poorer industrial districts, to group together older boys and girls of this type.

The Need for Promotion and Cross-Transference.—Where a special class has been formed to absorb all the backward children from a single department, and where the special class can itself be housed in the same building and under the same head teacher as the remainder, there is one strong advantage: it becomes easy to transfer the backward child to the special class directly his needs are discovered, and it is equally easy to re-transfer him to an ordinary standard so soon as he has caught up to the average level of work. This is a great gain. In dealing with such cases, fluidity is essential. Unlike the educable defective, the educationally retarded, as we have seen, frequently suffer from shortcomings that are temporary and acquired rather than permanent or inborn: grant them a short spell of individual care and intensive coaching, and their ignorance and apparent dullness may perhaps disappear.

There are, however, undoubted dangers. When a backward class is set up in the ordinary department, too often the prime motive has been to relieve the weight and pressure on the regular standards: the headmaster thinks first of the needs of the normal majority, not of the subnormal few. Hence arises a common prejudice against the backward class, as judged by less efficient samples; and many have asked whether such a plan does not imply sacrificing the unfortunate dullard for the sake of those who have already been treated more generously by nature and are far better able to look after themselves.

The reply is plain. The aims of the backward class must be positive as well as negative; it must seek, not merely to free the ordinary teacher and the average pupil from a hindrance and a drag, but also to do more for the backward child him-

self than can be done in the regular standards. In many instances, as a recent report has complained, ' the backward class is little else than a refuse heap for the rest of the school.'[1]

The one thing to deprecate is the solitary class for dunces, which aims at segregation and nothing more, where the sole object is to relieve the rest of the classes and the teachers, and whither all the unpromising pupils are removed, to be forgotten for the remainder of their school careers. Frequently the so-called ' backward class ' is just a standard O at the bottom of the school—the lumber-room of the whole department. Regardless of age, regardless of latent talent or capacity, regardless of all individual needs, any and every child who is considered a handicap to the normal standard and a nuisance to his teacher is dumped into the most inconvenient room, sometimes as many as 50 or 60 together ; there they may be placed in the charge of the oldest and least capable assistant ; drilled on an infants' reader or given mechanical handwork to keep them occupied ; and left to stagnate for the rest of their educational lifetime. They are not selected on the basis of any systematic tests; they are not treated according to their differing requirements. No one troubles to investigate the causes of backwardness in this child and in that, or to find out in which cases the backwardness may be remediable. The teacher, instead of realizing that he has been honoured with the most interesting problems in the whole school, groans because he will have ' nothing to show for his efforts,' and longs for the time to come when he will be promoted to take the ' scholarship class ' instead. ' Backward classes ' of this type are by no means rare, and have unfortunately done much to discredit the suggestion of instituting separate classes specially for children of this kind.

How far pupils of different ages, sex, attainments and capacities can be satisfactorily taught in a single room is an issue that still calls for further inquiry and experiment. As we have seen, the backward, like the defective, differ

[1] *Report of Joint Committee*, *loc. cit.*, p. 146. In what follows I have ventured to quote from a memorandum I submitted to the committee upon the general problem.

much more amongst themselves than ordinary children; and experience points to the need for classifying them into subordinate groups. Wherever possible, therefore, not one backward class but several should be organized (preferably, though not necessarily, in the same department), so that the backward can be graded at least as closely as the normal, and promoted each according to his own age and progress.

Many of the larger secondary modern schools are already organized on the basis of a treble or quadruple track, with 'A' classes for the bright and rapid learner, 'C' or 'D' classes for the slow, and intermediate classes for the learner of average intelligence. In such schools, therefore, it should be practicable to organize a fairly continuous course for the retarded child as he progresses from one class to the next. This type of grouping has received an indirect official blessing from the oft-repeated phrase in the Act of 1944 which urges that the education received by every child should be suited to his 'ability and aptitude'; and it would seem to be particularly appropriate after the age of 11 + when individual differences are tending to fan out more and more.

This policy of grouping or 'streaming' pupils according to their differing abilities has of late been subjected to considerable criticism from psychologists.[1] Nevertheless, most of the disadvantages to which they commonly refer arise, not so much from the principle itself, as from the relatively inefficient way in which it is sometimes carried out. The most frequent defects are, first, an inadequate study of the abilities and needs of the individual pupils prior to their allocation to the lower 'stream,' and secondly, inadequate arrangements for subsequent promotion and cross-transference. For some years to come there can be little doubt that the majority of the dull and backward will go to no special school or central class, and will attend no clinic or remedial centre for any intensive study or training. In such cases the only solution will be for the ordinary school, and particularly the larger secondary modern schools, to include one or more teachers capable of making the requisite

[1] Cf. the British Psychological Society's Report on *Secondary School Selection* (1957), pp. 42 f.

preliminary study and familiar with modern methods of coping with the dull and backward.

Supplementary Measures.—Where it is impracticable to institute a special class solely for backward children, it may be possible to adapt or partly adapt an existing class to serve a similar purpose. In many of the overcrowded districts the backward children are often delicate or unhealthy youngsters, whose mental alertness as well as physical well-being will improve remarkably when taught under the freer and more natural conditions of an open-air class. Such a class, whether organized as part of the ordinary school or as part of an open-air school as such, might be made incidentally to cater for the needs of the backward child. Or again, in the poorer districts more particularly, one or more of the special manual classes for older boys and girls could be set aside for receiving the more backward cases. And quite apart from special classes a number of alternative devices still remain. The ordinary standard, for example, may be divided into separate sections according to the pupils' relative ability; or the children may be re-grouped and sent to some lower class for their most backward subject. Such methods are particularly suited for isolated junior schools, where the numbers are too few for the formation of a separate class; and deserve a word or two of explanation.

(*a*) *Special Sections.*—The former of these two plans is the commoner. It is an expedient that might well be tried more freely. If the half-dozen most backward pupils are grouped as a separate section or 'set' within the ordinary class, and given an extra measure of individual treatment with a special time-table of their own, then a good deal may yet be done for them. An original teacher will have no great difficulty in modifying his methods to fit the particular requirements of the little batch. When this arrangement is made, every precaution should still be taken to prevent the child suffering in self-respect as a result. He should never feel that he sits on a separate bench because he is under a cloud. The teacher, indeed, should be clearly conscious that the child is different and needs a different treatment; but it is in no way necessary—on the contrary, it is distinctly harm-

ful—to force this difference on the notice of the child and of his class-mates. Counterbalance his backwardness in formal work by putting him forward in other ways. Give him his turn as ‘ cupboard monitor ’ or ‘ classroom prefect.’ If you cannot trust him to get all his sums right, show that you are ready to trust him in tidying up the desks and in keeping the inkwells filled. Give him a pride and a sense of responsibility in little practical affairs ; and this may outweigh his sense of failure when it comes to answering hard questions or reading hard passages in his book.

(*b*) *Reclassification for Special Subjects.*—Not every subject of the curriculum needs equal attention. Those in which backwardness is greatest, it will be remembered, are reading, spelling, and arithmetic : disability in reading, which nearly always entails backwardness in spelling as well, is commoner, we have seen, among the younger children, especially the boys ; disability in arithmetic among the older children, especially the girls. These, therefore, are the subjects in which easier work and additional help will most of all be required.

But because a child makes little or no progress in these more formal subjects, that is no reason for him to be penalized in every other branch of his work, least of all in subjects of a more practical or informational kind—singing, handwork, history, geography, and the like. Hence, in many cases, particularly with those who suffer from a limited or special disability or whose backwardness is confined to one subject only, the problem may be met by cross-classifying the child for the specific subject—reading or arithmetic, or whatever it may be—in which he is most retarded. If the time-table is synchronized throughout adjacent classes in the school, he may, for instance, be sent to a lower standard for sums and for sums alone, and continue to attend the standard suited to his general abilities during the rest of the school day.

Moreover, if special practical work cannot be provided in the ordinary classroom, it becomes doubly important that the backward child, just because his scholastic attainments are of a low level, should not be deprived of the practical instruction given in centres for manual training or domestic science. Too often these opportunities can only be

granted to those pupils who have reached a certain high standard in the more academic work. Hence the dullard who is relegated to a lower class is in consequence excluded.[1] I need hardly add that, whatever special arrangements are made during lessons, the backward child should always be encouraged to join in games with normal children of his own age and size when lessons are over, and to take part with other scholars in the general life of the department.

(*c*) *The Educational Clinic.*—A valuable adjunct to any scheme for dealing with retarded children is the psychological clinic. In the previous volume in this series, I urged the formation of a psychological clinic to deal with subnormal children, and discussed in detail its functions and organization. Here, therefore, I need not repeat the description. Since then, a large number of 'child guidance clinics' have been established in this country; and the value of the assistance which they can afford, not only to cases of temperamental subnormality—the delinquent and the neurotic—but also to cases of intellectual subnormality has become manifest.

There is, however, a common notion that the psychological clinic is a psychiatric clinic rather than an educational clinic—that its purpose is to give medical advice and treatment rather than educational advice and training. Some clinics, indeed, expressly exclude from their scope cases of severe intellectual retardation—the so-called feebleminded. But with children, although the co-operation of the doctor is indispensable, the real need, even where the trouble is definitely neurotic, is not so much psychiatry as re-education; and such a clinic might well cater for all kinds of mental subnormality. Teachers should be urged to send, not merely cases of moral or nervous disorder, but also cases of scholastic backwardness, special disability, and the like. As we have seen, many instances of backwardness are accompanied by, and even caused by, temperamental

[1] It may be added that the teacher in charge of the manual class, or the visiting teacher who gives instruction in technical work, often wholly ignores the peculiar needs of the duller pupils. He is apt to think more of his subject than of the children; and his explanations and diagrams remain quite unintelligible to the very children who might profit most by his work.

rather than intellectual troubles; and here readjustment of the home, of the school, and of the child's own attitude towards his problem, is almost as essential as in a simple case of psychoneurosis. But far more could be done in the way of remedial education.[1] During my work as psychologist in the Education Department of the London County Council, I found it frequently possible, with only six or nine months' special study and coaching, to enable a child diagnosed by his teacher as 'hopeless' in reading, spelling, or arithmetic—often in all three—to take his place in a class which was normal for his years. Still more frequently it proved possible, after a thorough psychological examination and a few trial lessons with the child, to suggest to his own teacher the appropriate lines which such coaching might follow.

(*d*) *The Educational Psychologist.*—An alternative plan, particularly suitable to rural rather than urban areas, is the visiting psychologist—a kind of peripatetic teacher, or inspector of backward cases and classes, who combines practical educational experience with psychological training, and goes round in a consultative capacity to the various schools. He can make a survey of each department by means of group tests, select the remediable cases, make an intensive study of each one, and so advise appropriate methods of teaching and training. The larger education authorities themselves, whether or not they ultimately establish a child guidance clinic, might well follow the lead given by several of the more advanced, and begin by appointing a full-time psychologist. Those who are not prepared to maintain an expert of their own may borrow his services from the Central Association for Mental Welfare. Such a temporary psychologist can institute a preliminary review of the problem in the area as a whole, suggest practicable means of provision, and give lectures, demonstrations, and even personal help to teachers in their special difficulties.[2]

[1] An increasing number of clinics are now paying attention to this aspect of the work.

[2] See the *Memorandum to Local Education Authorities on the Services of an Educational Psychologist*, issued by the Central Association for Mental Welfare, 24, Buckingham Palace Road, S.W.1.

In this way the teachers themselves may learn how to apply tests and how to make tentative investigations of individual cases upon their own initiative. Tests are helpful first of all (as we shall see in a moment) to aid in the selection of cases—a comparatively simple problem—and secondly to determine the type of treatment needed in each particular case. Here, however, a word of warning must be sounded : mental testing is not a thing that can be learnt from a few demonstrations or from one short course. A distinction should be drawn between those more technical tests which only a trained psychologist can intelligently apply, and those tests—particularly the standardized tests of educational attainments—which every teacher who has been properly instructed at college should be able to use. Let me repeat that a mere mechanical application of stock mental tests is often worse than useless. The value of the tests lies, not so much in the test result alone, but in its interpretation ; and this can rarely be achieved without a long practical experience of mental testing, and a systematic study of the whole background of each case.

(*e*) *Centres for Special Disabilities.*—There are many other supplementary measures that might profitably be tried by the more progressive authorities. One obvious suggestion is to increase the number and kinds of special training-centres established for the more exceptional children who suffer from disabilities of a limited type. Although their relative proportion is small, yet in a large and populous area the absolute number of such cases is considerable : a single child guidance clinic cannot possibly cope with all. In some districts centres have already been started for stammerers and those afflicted with special defects of speech ; similar centres might also be organized for those unable to read, or for those who find peculiar difficulty in spelling or number. Each child could be sent regularly every day for an hour's individual coaching to the appropriate class or centre ; there he would be dealt with along scientific lines by an educational expert who had specialized in the treatment of his particular disability. The expert would not only be familiar with modern methods of investigating the various causes of such troubles, but would have at his

command special apparatus and teaching devices which the ordinary schoolmaster cannot be expected to know or to employ. Many striking instances of so-called 'word-blind' children could be cited who have made rapid and remarkable progress after a few weeks' intensive training at the hands of a psychological specialist in this way; similar improvement can frequently be obtained with bad spellers and even with poor arithmeticians.

(*f*) *Special Coaching.*—But, as I have already indicated, except in the severer cases, there are many reasons why it is better for individual assistance of this kind to be given in the child's own school and by the child's own teacher. In the past the favourite plan was a little personal coaching given intermittently by the head teacher when he could spare time from other duties. This was often successful, particularly when the head teacher had enjoyed a wider experience than the class teacher (possibly in an infants' school), or adopted novel and unconventional devices which a class teacher might hardly venture to use. Nevertheless, it was not so much a method as a makeshift; and with the dull and the nervous such coaching often did more harm than good. However, all these accessory measures that I have just described must be regarded rather as supplementary or provisional expedients. The prime need still remains the systematic organization of special classes, expressly for the backward pupils, under teachers scientifically trained for the purpose.

Selection of Pupils.—There are many reasons why backward classes have so often failed; but the commonest is the haphazard way in which the members have been selected. In the past, when any definite system has been adopted, the favourite plan has been to delegate the choice of child to the school doctor. One incidental advantage of this method was that the doctor went round to different schools, and so could maintain much the same standard in each. But the chief argument seems to have been that backwardness must be an abnormal condition, a result of some physical infirmity—malnutrition, adenoids, bad sight, and the like, or else in itself a direct manifestation of a weak condition of the brain. The conclusions I have summarized above, however, make it clear that physical

defect and ill-health play only a minor part; and, in the present state of knowledge, to describe inborn dullness in physiological language as a form of cerebral inefficiency is rather a metaphysical postulate than an inference from facts, and not a very helpful postulate at that. We know far more about the working of the mind than we do about the working of the brain; and the study of the mind has hitherto not been regarded as part of the medical curriculum.[1]

Let us, therefore, recognize at the outset that, whatever view may be held of the ascertainment of the mentally defective, the ascertainment of the dull and backward is primarily an educational, not a medical problem; it is a matter for the school teacher, not for the school doctor. The doctor, when he has the time, will always be ready to assist in those special directions that lie within his ken—in discriminating between the merely dull and the truly defective, in searching for contributory causes of a physical nature, and in making practical recommendations as to hygiene or health. But the teacher must not wait for the doctor to urge upon him the need for forming a special class, or hope that at the next medical inspection the subnormal cases will all be picked out for him by some unique method of physical diagnosis. The head teacher must make the selection himself. He may rely on the class teacher's first-hand impressions; he may act under the general regulations drawn up by the education committee; he may seek assistance from the district inspector, or from some visiting psychologist who will undertake the actual testing and case-study; but, in the last resort, the head teacher should himself bear the prime responsibility for getting to know the exceptional cases in his school and for suggesting the special treatment appropriate to the needs of each.

In every case the decision should be founded, not upon a casual impression of the child's general progress, but upon a scientific study of his individual needs and limitations. Tests of intelligence and of school attainments should both

[1] Since this was written a proposal has been brought forward to make instruction in psychology an integral part of the curriculum for every medical student both during the pre-clinical and during the clinical stages.

be used. It is as important to discover what is the innate educational *capacity* of each child as to know his actual educational *achievements* at the moment of examination.

The use of standardized tests will be essential. Where a centralized class is established, recruiting its members from different departments, a more or less uniform standard must be observed by all the schools contributing. In such a case it is often contended that head teachers cannot make the selection, because each has his own peculiar notion of what constitutes a backward child. That, however, is no reason for leaving the nominations solely in the hands of the school inspector or the school doctor. They may know the standard ; but they cannot know the pupil like the teacher who has watched him day by day for several terms.

The ordinary teacher's knowledge of the attainments appropriate to each year of school life is nowadays admittedly vague. Older teachers, familiar with the early Board of Education codes, had some general idea of what was required for the several standards ; but the younger have nothing to go by except their own vague and unformulated impressions gleaned at the one or two schools where they happen to have taught. Most psychological investigators who make the round of various schools to study subnormal children from this angle or from that come back with the report that, more often than not, the teacher has missed one-third of the cases, and has nearly always under-estimated the backwardness of the few he has observed. But how can the teacher do otherwise unless, like the psychologist, he makes a systematic survey and employs some standardized scale ? With younger children more particularly, in whom the innate differences have not yet declared themselves sufficiently for the observation of the naked eye, it is almost impossible to gauge to nicety the exact degree of ability, unless appropriate tests, specially designed for that purpose, are methodically employed.

The recent introduction of modern psychology into the training college courses should do much to remedy these difficulties in the near future ; but mere lectures and bookwork will be useless unless supplemented by practical

work. The courses might well include demonstrations and discussions of various types of children, visits to special schools, watching the work in backward classes, and systematic exercises by the students themselves in mental and scholastic testing. By this means the new generation of teachers will be properly equipped for carrying out the necessary tests and making the necessary case-studies.

Age.—The age at which children are usually transferred varies considerably from one area to another. This seems the effect not so much of a policy deliberately adopted to meet the requirements of the new Act but rather of arrangements already obtaining before the war. In some areas an endeavour is made to ascertain which pupils are subnormal soon after they have been moved up from the infants' school; in others they are allowed two or three years' probation in the primary school; in the majority the main provision is made for those who have already reached the secondary stage.

In the newly established schools of the secondary modern type, teachers are now frequently complaining of the number of older children in their classes who are seriously backward. But this does not necessarily imply an increase in absolute numbers. As more and more places are provided in grammar and technical schools, a larger proportion of brighter pupils gets creamed off at 11; consequently the percentage of dull and backward children left in the modern schools is bound automatically to rise above the level that obtained in the corresponding classes before reorganization was instituted.[1] However, this apparent increase has furnished one of the strongest arguments for beginning with the provision of E.S.N. schools for the older pupils. But the difficulties which thus confront the modern school could be appreciably lightened if the problem was attacked more

[1] In many areas, between 20 and 30 per cent. are now transferred at the age of 11 + to the grammar school. If, therefore, the proportion of backward pupils was 10 per cent. before they were removed, it must rise to nearly 15 per cent. afterwards. This no doubt is one reason why so many teachers complain that the reorganization has actually 'created backward pupils.' However, as Dr. Roberts and others point out, the amount of backwardness remains virtually unchanged.

vigorously at an earlier stage. The figures cited in an earlier chapter show that at least one-third of the backward cases are preventable. Consequently the number of backward children at the secondary stage could be greatly reduced by more efficient preventive and remedial work in the primary school.

At present a disproportionate amount of time and effort is devoted to squeezing every likely candidate past the selection examination that admits the eleven-year-old to a much-coveted place in the grammar school. In the smaller schools, the attention thus accorded to the brighter youngsters in each class can be given only at the expense of the dull; in many of the larger schools, a kind of 'grammar school class' now frequently takes the place of the old 'scholarship class'; while in others the teaching and the curriculum are chiefly planned to secure a high achievement in the papers in English and arithmetic; and in some every pupil is coached on the problems that commonly figure in group tests of intelligence. The emphasis thus placed on success in formal work of an advanced or academic type is bound to have an adverse influence on the duller pupils, whose failure in the selection examination is a foregone conclusion, and who need a far more concrete type of approach. As a result, the cases of remediable backwardness tend steadily to increase in number from the age of 7 to that of 10 or 11.[1]

The remedy is obvious. In the primary school, a careful watch should be kept from the earliest years for pupils who are likely to suffer in this way. Some head teachers have established a special 'opportunity class' for those who need to go more slowly or who can be encouraged to catch up. Whatever device be adopted, it is of first importance to bestow some measure of individual attention on those whose intelligence is but slightly below average (those, for

[1] These statements are based, not merely on personal observation, but upon the comments of inspectors, school psychologists, and teachers in various parts of the country. See also the British Psychological Society's report on *Secondary School Selection* (pp. 44–8, 94 f.) for instructive comments on the unintentional effects of the selection examination in increasing the numbers of educationally subnormal pupils.

example, whose I.Q.'s lie between 85 and 95) to prevent them from dropping behind in the fundamental subjects.

At times, however, as our analysis of causes has shown, the real source of the child's backwardness may be traced to an earlier period still. At the very outset of his school life, the child may enter school with a handicap from which he is never entirely freed. The large numbers admitted to an infants' department at the beginning of each term often contain children from widely different homes. Nevertheless, they are still dealt with and promoted in groups, fifty it may be in a single class, regardless of all individual differences in mental capacity and in out-of-school experience. Accordingly, where the school is recruited from a mixed neighbourhood, it may perhaps be suggested that the children should be accepted, not in one large batch at the beginning of every term, but two or three at a time at the beginning of every month or week, as each attains the official age of entry. In the 'admission class' the dull and ignorant may then be detected at the very commencement. Thus, even in the infants' department, two types of special 'opportunity class' may occasionally be desirable, one at the initial stages to make up for the shortcomings of these tiny pupils as they enter and to do the work that in better circumstances might have been done at home or in a nursery school, and a second for older infants who have lost ground owing to absence, so that the gaps in their school knowledge can at once be filled.

It is essential, therefore, that the backward child should be discovered and taken in hand at the earliest possible moment. The sooner he is detected and given the special attention that he needs, the surer is the hope of removing, or at least of compensating for, his particular type of disability. One of the greatest obstacles to speeding up the progress of the older retarded child is the child's depressing sense of his own inferiority. Before the age of 11 he may hardly have realized his unfortunate position. But, with the growth of self-consciousness that the approach of puberty brings with it, he begins, as we have already seen, to contrast himself with his normal fellows, and to feel humiliated if he is taught along childish lines. Hence the later his backward-

ness is attacked, the smaller are the chances of success. To ignore the backward child until he has reached the age of 11 or more, and his backwardness has forced itself on every-one's notice—on the teacher, on the rest of the class, on the backward child himself—until in fact he becomes a con-spicuous nuisance to all concerned, or, worse still, to wait until he is on the verge of exchanging school for industry, and then to try slapping a final polish on him—this is a common, but a blind and ineffectual policy ; it is like wait-ing until the consumptive breaks down at his post before giving a thought to his trouble and cure.

On these grounds, therefore, in schools that still cover an age range of 7 to 14, many head teachers have preferred to place their backward class at the lower end rather than at the upper. They have formed a kind of observation class to which doubtful pupils can be provisionally sent on first enter-ing the new school. When the majority of the cases are of a remediable type, this is undoubtedly the most useful place.

Where, however, the cases are nearly all pretty hopeless, and where in consequence there is bound to be an almost equal number of dullards in every age-group, then a favour-ite plan is to put the backward class, as it were, in the centre of the scale, and to recruit it chiefly from children of the intermediate ages. Two reasons are commonly urged in favour of this course. First, it is said that, when the children come up fresh from the infants' department, they deserve a probationary period in one of the ordinary classes, to see what they can do. Secondly, it is claimed that the older child recovers his self-confidence and self-respect if he re-turns once again to an ordinary standard, to spend his last year with his normal fellows, at the upper end of the school. The employer, it is often added, will probably ask the lad what standard he was in before he left, and is more likely to engage him if he can reply that he 'left in standard VII.'

Such reasons are not altogether convincing. With modern tests a preliminary trial in the ordinary classroom is no longer a necessity ; and to place the unprogressive pupil in a high standard merely for the sake of its name and reputation is fair neither to the child nor to the employer, nor yet to the class. There are, however, stronger grounds

for this plan when only one class can be established. At the earlier ages the backward child's backwardness is less marked; and he can, therefore, be taught with some measure of success along with more normal children provided the class-methods are fairly flexible. Again, during his last two or three years of school life, he and his fellow pupils are old enough to carry out individual work, and in many schools the work, even in the ordinary classroom, is then of a more practical nature. It is during the intervening stages that a spell of intensive coaching in a small special class is likely to yield the best return.

Nevertheless, in schools that are still organized on the older basis, the institution of a single backward class to cope with all the backward children ranging from age 7 to age 14 is certainly inadequate. Two backward classes will always be more than twice as effective as one; and the foregoing arguments suggest that the two classes may often have very different aims. There may be, first of all, an 'opportunity class' for those who are all but normal in general ability and backward merely in school work, and, secondly, a 'practical' or an 'industrialclass' for children who are innately dull and whose backwardness is therefore permanent. The two need widely different types of work and very different teaching methods. In general, as follows from what has just been said, the first type of class will consist mainly of younger pupils and the second of older.

But there should always be, at the very least, a double review and a double re-classification: one at the age of 7 or 8, when the child leaves the infants' department, and another at the age of 11, when, with the newer organization, the 'clean-cut' is commonly made, and the whole school population re-sorted and re-grouped. This would imply, as the best general solution, a backward class for children of 7 to 10, and a backward school or 'stream' of classes for those of 11 to 14. In the near future, as a consequence of this reorganization, and doubtless in view of the raising of the school-leaving age, many authorities will be planning new buildings and remodelling old. Here, therefore, is a unique opportunity, not merely for establishing, perhaps experimentally, special schools for the more

backward seniors, but also for arranging smaller classes, though not smaller classrooms, within the ordinary senior and junior departments.

In my view, however, no single solution can be pressed on all authorities alike, or even carried out in all districts under the one and same authority ; and rather than lay down any hard and fast recommendation I would strongly urge the encouragement of free experimentation, with a careful study and record of the results achieved with each scheme and of its suitability to different local conditions.

The Selection of the Teacher.—Care and forethought will be required, not only over the choice of the pupils, but also over the appointment of the teacher. His age, his health, his whole personality, as well as his general efficiency and his particular gifts, must be reviewed in close relation to the requirements of his task. In the past, head masters have been too prone to consider, not which of the assistants is best fitted for the backward class, but who can best be spared from teaching the more promising pupils ; and this has frequently meant that the teacher ultimately allotted is either the youngest and the least experienced, or else the oldest, the least competent, and the least progressive. Yet it is obvious that the teacher of the dull and backward, like the teacher of the mentally deficient, needs special qualifications for his work. There is a widespread notion that, for the backward as for the mentally defective, a person of placid temperament and motherly ways is the best. But with the higher grades, such a teacher rarely succeeds in bringing out all that is latent in the slower pupils, or in stimulating the sluggish to the utmost of their powers. What is wanted is a bright, adaptable person, physically active and mentally vivacious, firm, patient, sympathetic, and inspired by strong common sense.

The teacher of a backward group is bound to figure more largely in the lives of his pupils than he would in those of normal children. He must deal with them, not in the mass, but as individuals. Each child should come to look upon him rather as a personal tutor than as the master of the class. Hence, to be successful, he must regard his task, not as a thankless burden, but as a privilege. Interested as he must

be in human nature, he will rejoice to find himself confronted with a unique opportunity for studying different types of mind—types at once the most puzzling and the most fascinating that the elementary school can offer. He will need a first-hand knowledge of difficult youngsters, and a sharp eye for the symptomatic peculiarities of their everyday behaviour. He must cultivate alike a human and a scientific attitude towards each one, and towards the various problems that beset them. He should be acquainted with the most modern educational devices, especially the numerous individual methods that have been recently worked out for training the immature mind—those, for example, now adopted in the more progressive infants' departments and in the schools for the mentally deficient.[1] At the same time, he should be able to appreciate the maturer and more worldly interests acquired by the older boys and girls within his charge. He should, in short, be a man of a practical as distinct from an academic turn of mind, with leanings that are concrete rather than bookish, a talent for manual work and expression rather than for what is merely literary or scholastic. A knowledge of music, eurhythmics, and the simpler forms of handicraft, is desirable ; if he has made a hobby of some definite art or industry, so much the better. But versatility is more needful than specialization, and an interest in human beings more essential than an interest in any particular branch of study.[2]

[1] This might be more readily achieved if freer use were made of the practice, already adopted by certain authorities, of exchanging teachers between ordinary and special schools, and between the different departments.

[2] In the new senior schools there is an increasing tendency to appoint specialist teachers. Such teachers are even less likely than the ordinary senior school assistant to be familiar with the needs of the backward child. They will know nothing of the modern methods for teaching the elements of reading and of number, and, outside their special subject, will have little acquaintance with the wide variety of handwork and craftwork that is required for the duller children. Further, the mere fact that the backward pupil is taught by several different teachers generally means that his individual needs and his character as a whole are understood by none. If, however, the observations of the various teachers are systematically recorded in a progress-book, there will be a gain in the multiplicity of viewpoints : but I still believe it will be an advantage for one teacher to be primarily responsible for the psychological study of the child.

Many of these qualifications can be acquired; but some can only be attained through appropriate training and first-hand experience. Indeed, the whole technique of investigating, handling, and educating the backward and the dull is itself so specialized that the ideal teacher needs to have had explicit instruction on his problems. The methods of investigating individual cases might, as I have already indicated, to some extent be taught in the training colleges ; and additional courses could perhaps be offered for those proposing to take up this work. But to concentrate the attention of the mass of younger students too closely upon abnormal cases would be unwise ; nor is an intending teacher able to appreciate the value of special methods of instruction until he has had some experience at first hand of the difficulties they are designed to meet. Accordingly, the most urgent need of all is a series of courses for those already engaged in such work. Of late, many authorities have begun to arrange evening lectures dealing with the psychology of the backward child, and with subjects, such as handwork, particularly appropriate to his needs. Under the auspices of the Board of Education, the Central Association for Mental Welfare has also organized courses for teachers of retarded children. These and similar facilities might well be extended.

Size of Backward Class.—The outstanding need of all retarded children is, we have seen, more individual attention. Hence *the first and fundamental requisite of the special class will be its small size.* If we assume that in the near future the ideal class in the ordinary elementary school will average no more than 40, and that the ideal class in the special school should average about 20, then we may reasonably suggest that the class for the dull and backward should be intermediate between the two, and should not exceed 30 in number.[1] The backward class, therefore, will be the smallest

[1] The composition of the class may have almost as much influence on its progress as its size. The attitude of each individual towards others, and the tendency for favourite pairs, leaders, and cliques to emerge, are well worth systematic study, and when suitably and silently managed may do much to aid discipline and industry. See below, p. 630.

in the department. But the classroom itself should be one of the largest. As we shall see in a moment, extra space will be required for manual and practical work, and plenty of room will be essential if the children are to move about with freedom.

Hitherto the need for the numbers to be small has formed one of the chief obstacles in the way of establishing and maintaining such classes. If the regulations in regard to staffing allow one teacher only to 44 children on the roll, and the scale is to be strictly observed, then a school of 300 cannot have a class of 30 ; a school of 270 may have two ; but, if in six months' time its numbers drop to 260, then the staff will be reduced from seven to six and the backward class will be disbanded. I am tempted to urge, therefore, that the requirements in regard to staff might be on occasion relaxed and head teachers notified accordingly, and that, where necessary, the cost of an extra assistant be willingly faced and accepted. In the long run the additional outlay (which would not always be essential) would be more than repaid by the increased efficiency of the school and the immense advantage to the pupils, normal and backward alike.

Case Studies.—Having selected the pupils and found a suitable classroom, how is the teacher to proceed ? There is no cut and dried curriculum that can be offered. The best plan will be to keep the syllabus elastic, and let the scheme of work grow gradually, in close adjustment to the needs of the particular class. Let the teacher think to begin with, not of the subjects, but of the individual pupils.

The first thing to do with the backward child is not to hurry up and teach him, but to try and understand him. Lack of school progress is a symptom only ; and, before the symptom can be successfully treated, it is essential to study its precise nature and to discover its probable cause. Each child, therefore, must be made the object of a small intensive research. From the practical standpoint, quite as much as the theoretical, it will be important, while making the first preliminary tests, not only to ascertain the mere fact of his backwardness, but also, as far as may be, to analyse its extent and direction, and to explore the probable factors that may be contributing to produce it. It will,

for example, rarely be sufficient to examine the child's intelligence and school attainments alone; his temperament must be considered; his interests and special talents must be canvassed; his home conditions and the hindrances to his previous development must be taken into account. All this implies that for every backward child a complete case-history should be compiled from the very outset of his school career.

Progress Records.—And the case-histories should be kept up to date. For every child in the backward class a systematic record of progress and development should be preserved. The progress-books in use at the schools for the mentally defective might serve as a pattern. But the headings, as at present printed in their margins, are based on an improvised or out-of-date psychology, and need revision.[1] From time to time each child will be re-examined and re-tested; and the results, together with detailed observations on his development, should be methodically entered up at least once a term. Any improvement, deterioration, or change in his apparent abilities or general attitude, should be noted; and the whole *dossier* should follow the child when he is passed on to a new class, a new teacher, or a new school.

So far as possible results should be recorded in terms of standardized tests. The common type of entry—' Memory —poor '; ' Reading—good '; ' Calculation—nil '—means nothing. Where precise measurements or marks are out

[1] I understand that the teachers of special schools have long had this project in mind and have suggested that a Committee of the National Special Schools Union should be set up to consider it. For the backward child and the defective the detailed headings will necessarily diverge a little; but the same underlying scheme may be employed for both. I suggest it should be based on the main distinctions I have already emphasized: I. Environment. II. Personality. A. Physical Condition. B. Mental Condition: (1) Intellectual: (*a*) Innate—(i) General, (ii) Specific; (*b*) Acquired (educational attainments in detail). (2) Temperamental: (*a*) Innate—(i) General, (ii) Specific; (*b*) Acquired (nervous and moral traits in detail). See the schedule printed below in Appendix I. It should be observed, however, that while in the preliminary investigation emphasis should be laid rather on discovering the *natural* capacity and temperament of the child, in the progress records emphasis should be laid rather upon his *acquired* intellectual, moral, and social attainments.

of the question, a simple rating-scale such as I have described in an earlier chapter[1] should be employed. When writing up the case-studies of the new-comers, or filling up the progress-books of the older pupils, care should be taken to specify precisely what each one can actually do. Jot down actual examples, showing not only where the child succeeds, but also where he fails, so as to define the exact limit reached. This is particularly helpful in arithmetic and number: state, for example, how far each child can count, or what he can manage and what he cannot in each of the four rules, simple and compound. But nearly all the more important subjects, reading and spelling as well as arithmetic, can be split up into definite units; and it will be helpful to attempt a schematic tabulation of words or processes to be learnt and practised during the term, together with graphs of each individual's progress. Often, indeed, the pupils can be taught to keep such records for themselves. Since, in the daily work of the classroom, each child is to follow his own bent, there will be erratic gaps in his efforts to cover the general syllabus; and in various directions different children will rapidly reach different levels. But if the plan I have suggested be adopted, the teacher will not only have a clear basis from which to begin, but also will be able to keep track of each child's progress from stage to stage. In the long run the time spent on such records will prove far more fruitful than if it had been devoted to undirected teaching.

Medical Attention.—As we have already seen, physical defects and bodily ill-health may form a definite factor in the child's retardation, and, even when they have not caused the backwardness, may still hamper any attempt to remove it. Hence a special medical examination should be undertaken for each backward child at the very start; and special arrangements should be made for correcting the defects so discovered as promptly as possible. Detailed suggestions regarding the most important points to note have already been put forward in the preceding sections of this work. It should be remembered that a physical trouble

[1] See above, p. 26.

may be too slight for the child to complain or for the brief routine inspection to reveal it, perhaps even too slight for the hospital or family doctor to give it much attention when it has been noticed; nevertheless, it may prove a serious obstacle impeding the child's progress at his intellectual work.

It follows that, to be of real service, such examinations will have to be far more thorough than those of the ordinary inspection. They should be carried out by a medical officer acquainted, not only with the special disorders of childhood, but also with the way in which they react upon mental and scholastic development. In the near future, it is to be hoped, courses in practical psychology will be introduced into certain parts of the medical curriculum; and this, combined with first-hand experience at one or other of the new child guidance clinics, should yield a better supply of specialists equipped with the training required. Meanwhile, it will often be convenient if the study of the child's physical abnormalities is carried on at the same time as the study of his psychological peculiarities and social conditions. Accordingly, in certain districts it may be wise as well as practicable to arrange for these preliminary investigations to be made at one of the clinics themselves.

Social Conditions.—Although in at least half the cases, as our survey has revealed, educational backwardness is mainly or primarily due to some congenital or developmental subnormality of the mind—a subnormality that would still persist even under ideal conditions of living, yet in a large proportion this innate inferiority is further aggravated by handicaps imposed by the material and social environment of the child. In other cases, where there is no inherent mental subnormality, the home conditions, even if they are not directly responsible for the backwardness, may nevertheless, while they persist, make the task of dealing with it doubly difficult. Social service, therefore, is quite as essential for the dull and backward as it is for the mentally deficient; and with the former will usually be attended by more remunerative results.

An increasing number of education authorities already have some system of social service attached to their

schools—children's welfare committees, care committees, and the like. The active co-operation of these workers should accordingly be enlisted whenever possible. Every effort should be made to influence parents and others to secure for the backward child adequate nourishment, fresh air, proper recreation, sufficient clothing, sound foot-gear, and whatever medical or surgical treatment may be necessary. Milk-meals in the middle of the morning, even wholesome dinners in the middle of the day, should, when required, be provided at the school. Nowadays, as we have seen, lack of sleep and of proper sleeping conditions, though generally overlooked, seems even commoner than inadequate or improper food, and quite as detrimental in its effects on mental efficiency. Often, therefore, it may prove desirable to supply not only meals but even sleeping quarters for necessitous cases: occasionally perhaps the school premises (for example, a sheltered roof playground) might be exploited for this special purpose. But, as I have insisted above, bad homes are not made by poverty alone. The psychological conditions are even more important than the material. We have, for instance, already seen what a large proportion of backwardness is due to emotional or temperamental disturbances arising from troubles within the family, troubles which might easily be set right, but of which the teacher or the doctor knows nothing.

Even where the home circumstances are satisfactory as judged by the requirements of the ordinary child, there are nevertheless many minor difficulties that are likely to arise over the management of the dull or backward. Here a little expert advice may be welcome to the parent. Left to themselves, few backward children know how to make a right use of their leisure hours. Indeed, in the case of such children, the aid given by the local authority to the various voluntary agencies that organize play centres, happy evenings, and vacation playgrounds, might be profitably augmented. Without some such provision beyond the school walls, all that is done by the teacher during five short hours on five days a week may be undone directly the child escapes from the teacher's sight. Every effort should be made to bring the

parents into close co-operation with the school. Open days may be fixed when mothers can visit the school; parents' councils can be formed; explanations can be given by pamphlets, or by personal talks with the teacher, as to the best way of handling the child out of school hours. Above all, for children whose homes are unfavourable, school itself may become a second home.

Attendance.—Where a child is, or has been, irregular in his attendance, a special inquiry should be made and occasionally special pressure applied. Many, indeed, may deem it legitimate, particularly where time has been lost through continued or frequent absence, to urge that the education of the backward should be prolonged beyond the normal period. Merely to tighten up the attendance is a recommendation that is not so straightforward or mechanical as it sounds. Where the head teacher's salary depends on the grading of his school, and where the grading depends in turn on the number of attendances, there may be some temptation to bring children to school even when their health demands a longer absence. The teacher rightly objects that the parent cannot always be trusted to judge fairly on this point: accordingly, the natural arbiter would seem to be the school doctor. In the long run it will usually be found wiser to secure attendance by other measures than compulsory enforcement. The best expedient is to make the curriculum in these special classes so attractive, so real, and so patently useful, that the young defaulter actually prefers lessons to the stolen joys of truancy.

Objectives.—The foregoing, however, are all preliminary or incidental measures. I turn now to the essential task of the teacher—the instruction of the children themselves.

In considering the aim of the backward class it is necessary to distinguish between those pupils whose backwardness is accidental or acquired and those whose backwardness is innate and permanent. In the former case transference to a backward class is to be regarded as nothing but a temporary expedient. Individual attention as regards teaching, school attendance, social conditions, and bodily health, should result in progress being so speeded up that all who are not dull as well as backward should, after one or two terms, be

fit for re-transference to the ordinary class. In most schools, as we have seen, these curable cases are the rarer of the two main types; they are found chiefly among the younger children. More rarely still a child's rate of mental development may profoundly change; and he will, as the parent puts it, 'grow out of' his dullness. In addition, there may be a few exceptional boys or girls whose specific educational ability, as judged by the regular subjects of the classroom—reading, writing, and arithmetic—will always remain below their manual or technical powers, but whose general intelligence is equal to or even above the normal. It is unjust to group these, all through their school career, for ever with the dull. The ideal plan would be to pass them on, towards the age of 11, to some special post-primary school where the curriculum has a practical bias. Such cases, however, are relatively infrequent: intelligence manifesting itself to a high degree in one direction (for example, handwork) is not as a rule accompanied by a very low degree of ability in other directions (for example, the more academic subjects).

With the majority the backwardness is all-round, innate, and ineradicable. Their school progress is retarded because their whole mental growth is retarded. And, since with them the period of growth will last no longer than with other children—indeed, it will probably cease a little earlier—they must always remain dull, and can never hope to reach the average level. In most instances, therefore, children transferred to auxiliary classes will need to stay there for the rest of their elementary school lives. It is for this reason that I have already urged that, where children enter these classes several years before leaving school, more than one special class should be established; and it is for this reason that I deplore the ephemeral nature of so many of the backward classes I have seen. Teachers seem often to suppose that backwardness is an exceptional or occasional phenomenon: their attention is drawn to a little group of laggards; they make special arrangements for these few; soon the brightest catch up and the oldest leave; and so, only a year or two after it was formed, the class is disbanded.

With those who are likely to be permanent cases the ultimate aims should not be too ambitious. On an average,

I estimate the progress of the dull to be about three-quarters that of the normal. By the age of 14, therefore, their educational attainments will correspond to standards IV and V. With the genuinely dull more than this should not be aimed at in the formal subjects. For them we must frankly adopt a policy of limited objectives. If standard IV marks the limit of fire, it is foolish to train the gun on a target which lies several stages beyond. Moreover, an aim that is too lofty will sometimes hit nothing at all: a modest 60-pounder with a low and gentle elevation may often in the end carry farther than a noisy howitzer that shoots high into the air.

Curriculum.—The curriculum, then, in the special class will usually differ from that of the ordinary class in two important respects: it will differ in range, and it will differ in quality. From what I have just said it plainly follows that all work which in the ordinary lower classes—standards I to IV—would be merely preparatory to work in higher classes should be excluded from the syllabuses for the backward groups. For example, it will be utterly useless for such pupils to learn how to spell words of a literary type that would never be used in writing by any adult whose mental age is below 10½ or 11. Again, a knowledge of the abstract terms or rules employed in grammar and arithmetic will never be wanted: the most that they need are automatic methods of speech and computation, not the power to explain or justify them. Indeed, in the case of the dullard, many of the skilled methods which a normal child ultimately acquires may be dispensed with: the use of a ready-reckoner will save hours of painful drill over tables. To teach what methods are required by dint of sheer practice instead of by the intelligent application of an abstract rule is admittedly a longer procedure; and a conscious understanding of the principles is therefore rightly attempted with the normal. But with the backward it is seldom successful and can never lead to a permanent result. Hence with them the slower but surer mode of instruction must be adopted.

In planning for the dull pupil, then, we must from the very outset arrange that his curriculum covers less ground;

and this will enable him to take shorter steps. Once again, however, it will be needful to discriminate between the hopelessly dull and the merely backward. Often what the latter really want is not so much an entirely reorganized curriculum, but a little personal help or a few judicious hints to enable them to surmount some minor obstacle at which they have stuck. Study the child's errors; watch his peculiar mode of attack: and this may at once reveal the reason for his failure. Perhaps no one has shown him the right way to tackle his own special difficulty; and in consequence a trivial misunderstanding has held up his progress for months. Perhaps he has missed or forgotten some essential scrap of information; and, as soon as this is supplied, he is able to forge ahead.

Nor must we expect the dull and backward to display the same evenness of attainment as the normal pupil. Consequently, the proportion of time allotted to the various subjects will be quite different from that set out in the time-table for the normal. In dealing with the normal we can safely assume that most of them will develop in all directions at an approximately equal speed, and so reach much the same level in all subjects at any given age. But some subjects depend far more on general intelligence than others. Hence, the dullard's backwardness will be most conspicuous in those subjects that mainly depend on sheer intelligence for their pursuit. As a rule, he will appear most retarded in problem arithmetic and in logical composition—particularly at the older years; in comprehension of printed matter he will generally prove less incompetent, except at the earliest stages; spelling will give him much greater trouble than mere mechanical reading; in drawing and handwork his retardation will seem comparatively slight; and his writing, though slow, may be almost as clear as that of a normal pupil.

Accordingly, in deciding the level of attainments at which the syllabus should aim, the teacher must take these variations carefully into account. At the very outset the child's backwardness will, no doubt, show up most of all in reading and those subjects that depend upon it; but reading proves a far more teachable subject than arithmetic or

orthography.[1] Hence, the teacher must not be surprised if the child's power to read soon advances well beyond his power to spell or calculate. In these latter respects what can be done by the teacher seems much more severely restricted by the limitations of the dull child's intellect. Here, therefore, it will be useless to try to force the pace.

But even the reading of the backward child should possess a practical aim and interest, instead of forming a mere academic exercise in pronouncing hard words in print. Let him learn at least to decipher the everyday notices and signs that he sees around him; to follow the printed instructions for making things, for using things, or for getting to certain places; to understand the circulars, the announcements, the official forms, which nowadays are showered on every inhabitant of a civilized community. And in general, no matter what the subject to be taught, let the teaching be so planned that the aim and outcome are rather to make the child an intelligent citizen and a competent worker than to turn him into a sound or accurate scholar. Our chief object must be to equip him to meet those difficult problems of later life—in industry, at home, and during the hours of leisure—which a brighter child would be able to solve by his own unaided wits. In industry, no doubt, his duties will be

[1] Under present conditions this seems true, to some extent, even of the normal child. I have recently been revising the standardization of certain educational tests originally drawn up just before the war. I find that the reading tests are now a fraction too easy, and the spelling and arithmetic tests a little too hard. No doubt various factors have contributed to bring about this change. Nowadays, we lay far less stress upon pedantic exactitude in spelling and in number; during the war, arithmetical accuracy suffered considerably; and even before the war it appeared to have been declining, slowly but steadily, ever since those ancient times when every pupil was driven and drilled for ten months in the year in order to get two sums right out of his four when His Majesty's Inspector came round at the end of the annual period. Nor, of late, have we given the same attention to improving methods of teaching arithmetic as has been bestowed on the improvement of teaching-methods in reading. Indeed, the modern principles of individual work are thought by some inspectors to penalize the pupils' efforts in arithmetic almost as much as they favour them in reading and composition. Nevertheless, in spite of all these contributory influences, the fundamental factor is, I believe, psychological: where innate abilities are limited, reading remains far more teachable than calculation; and here an improvement of teaching-methods is likely to yield most fruit.

simple: the spelling, writing, and calculation that an employer would expect a young office clerk to have acquired at school will never be demanded from the dull adult, because dull adults can never take up, or at any rate never retain, such vocations. Let us, therefore, resign ourselves to the child's inevitable limitations, and make the most of the particular gifts in which he is strongest. Over the very things about which the ordinary class teacher is most concerned the dullard will be insuperably slow; but he will not be so slow in comprehending things that can be seen by the eye, or in making things that can be put together by a pair of practised hands; and, through seeing and making, an excellent general education may still be imparted.

It follows that the whole syllabus for the backward class will lay far less stress on typically scholastic subjects—the three R's of the traditional curriculum—and devote far more time to concrete, manual, and utilitarian work. The old-fashioned notion that, because the backward child is so slow in picking up the more formal work, therefore he must spend more time over it, is not merely mistaken; it is positively harmful. Under such a plan he is so pressed and occupied with a syllabus designed for brighter pupils than himself that he has no time to discover that after all there are many intelligent interests still open to him—wholesome and simple activities which have brought pleasure and usefulness into the lives of the masses throughout the history of man.

Teaching Methods.—In regard to actual instruction, the general principles will be these. First, the average pace should be nearly twice as slow as with the normal child of the same years. Roughly speaking, the backward child will require to be told the same thing twice as often; to have twice as many exercises on the same problem; and to go by steps that are twice as gently graded. Secondly, since the dull child is so limited in his powers of understanding abstract notions and of grasping ideas at secondhand through words, the teacher will have to present ideas so far as possible in the concrete, and rely mainly on instilling well-drilled habits rather than on getting the child to appreciate abstract formulæ and generalized rules, in the hope that he may apply them on the proper occasion.

At the same time, it is to be remembered that, while the teaching methods should be simplified in these various directions, the subject-matter to be taught and the general mode of approach should not be so condescendingly childish as they would be in dealing with younger and more normal children of the same mental age. To treat the backward boy of 11 as though he were an average youngster of 8, to give him a standard III reader, and to set him standard III sums, seems an obvious and a common principle, but more often than not it defeats its own end. It bores him; it discourages him; it arouses the contempt both of himself and of his fellows. A special technique of instruction must, therefore, be created to suit the peculiar needs of the backward class: new syllabuses, new time-tables, new textbooks, new modes of attack must be devised, and the whole task of education taken up from a new angle.

Here, indeed, lies a valuable field of experiment for the enterprising teacher. Meanwhile, the following broad suggestions may be laid down.

(*a*) *Physical.*—First of all, as we have seen, these children not only display more physical weakness than the normal, but are less able to withstand its mental effects. A bright child, if he has a headache, or is a little out of sorts, will, as a rule, carry on; the backward child, whose powers of attention are feeble at the best of times, is more likely to give up altogether. Mental vitality depends largely on physical vitality; and hence everything should be done during school hours to keep the duller weaklings physically fit. Plenty of bodily exercise should be introduced, particularly in the shape of games, organized and unorganized. Gardening forms a useful adjunct. But, whether healthy or not, backward boys and girls of almost every type do well when working in the open air. Those who come from poor and overcrowded homes would, perhaps, benefit most of all by being sent to open-air schools and open-air classes. The effects of the catarrhal conditions which, as we have seen, are so rife among children from the slums would be greatly diminished, and the physical condition of each one be braced and toned up.

In the ordinary school, the classroom should be chosen

so as to be near the playground exit. When the children seem tired or their interest temporarily flags, they can then go out for a free run, or for a little sharp short exercise in the fresh air. Oral lessons can often be taken in a sheltered corner of the playground with the children sitting on mats. Indoors the benches need not be screwed down to the floor, nor the children to the benches. The backward class will, as we have seen, spend far less time on sedentary work—reading or writing at a desk, or sitting still and listening to the teacher. Hence portable tables and chairs might well be substituted for the ordinary school furniture, so that the children may have more liberty and room to move about.

(*b*) *Manual.*—Since the curriculum is to be predominantly manual, both space and special equipment will be required. To a large extent the classrooms will be practical work-rooms ; tools, materials, and other apparatus will be needed, even more than the usual stationery and textbooks. Supplies expressly purchased are by no means indispensable. An enterprising teacher can work wonders with cardboard, cotton-reels, canisters, and the innumerable household odd-ments which the children will be only too eager to collect and bring to school.

Handwork, however, is not the sole panacea. Handwork, merely as handwork, must not be thought of as a special activity appropriate to the backward child. Too often the teacher sits back content when he has set the dull child doing something with his hands, and hopes that the dull mind is thereby usefully occupied. Plaiting, knitting, simple weav-ing—much of the handwork seen in special schools and classes, tends to be purely mechanical, and, where no controlling purpose is involved, so far from keeping the mind really busy, merely leaves it free to daydream : it acts not as a stimulant but as a soporific. No doubt it affords the youngest and the dullest an easy means of accomplishing something that is visible ; and, in small instalments, will provide a welcome mental rest. But its direct educational value is negligible.

Generally speaking, the teacher should choose particular types of work, not merely because they exercise the muscles and require controlled and co-ordinated movement, but

also because they involve concrete problems, and so provoke thought and encourage self-correction, because they broaden the child's interests and lead to a knowledge of materials and their handling, and, above all, because they bear closely on other work both in the classroom and in the field of occupation to which the child will probably be called in after-life. Ultimately, no doubt, it will be possible to elaborate a systematic and graded course of instruction in various media. Plasticine, clay, paper, cardboard, strip wood, string—the more tractable materials should obviously be used to begin with; dress fabrics, wooden boards, leather, and metal—materials that call in increasing degrees for exactitude and care—will be progressively introduced in the later stages.[1] But there are dangers in systematic courses, unless they are governed at every point by psychological principles as well as by educational ideals.

Avoid at all costs converting 'manual subjects' into yet another set of collective lessons. An inspector tells me how he once suggested the introduction of woodwork as a suitable subject for a class of 30 backward boys: the teacher forthwith requisitioned 31 saws, 31 planes, 31 hammers, and 31 chisels. Evidently he proposed to demonstrate the use of each tool himself, and expected the whole class to copy him, step by step, in unison. I myself have known an instructor in the workroom commence each morning with a lecture on shoe-repairing, illustrated by operations on an ancient boot which many of the boys could neither see nor follow. It is far better to let each lad start straight away on his job; and leave his own productions, good, bad, or indifferent, to point their own moral. Let him choose his own task, and so set his own problem; let him work at it with a minimum of help; and let him judge his success by the final results without comment from the teacher. Incidentally, when different pupils take to different tasks, each according to his mood or interest, there will be less need for massive equipment, such as few authorities are as yet willing to supply.

[1] Excellent ideas as to suitable crafts, materials, and methods will be found in Mr. Arthur Allen's book on *Art and Artistic Handicrafts for the School* (Harrap & Co., 1932). But every education library will possess a supply of special textbooks dealing with the different branches of handwork.

Precision should not be expected at the outset. Fine movement and delicate manipulation may be postponed to a comparatively late stage. Start by using the larger muscles and the bigger joints, and proceed with the smaller as the child grows older and acquires more skill. With the younger it is a mistaken policy to insist on accurate measurement or high finish. So far as possible, the children, not the teacher, should decide what is to be made. It will then be found that the beginners care little for the humdrum articles that figure in the usual syllabus—trays, soap boxes, and paper racks. The boys nearly always prefer making something that moves or assists in movement—railway signals, scooters, miniature carts made out of sugar boxes running on the wheels of a discarded perambulator ; the older want things that ostensibly have a practical use—seats, fences, sheds for their little gardens, or properties and scenery for their dramatic performances. Girls, if permitted, can handle a saw and a screwdriver almost as efficiently as boys ; nor will they think it unfeminine to make a fowl pen, a rabbit hutch, or a wheelbarrow. Generally, however, tradition turns their enthusiasm more towards the domestic arts. Dolls and a doll's house can be made centres of interest and instruction, and that until a far later age than is commonly believed. Much can be successfully taught in this way—the management of the baby, the making of simple and sensible clothes, the furnishing of a working man's home. With both sexes a toy theatre will give ample opportunities for handwork of various kinds, and all manner of information can be incidentally introduced : here and elsewhere the teacher need not be shocked if the children adapt and combine the most unusual materials in ways that run counter to all the syllabuses that were ever compiled. The same general aims should be observed even in the lighter forms of handwork. Drawing and painting should mean creating things rather than copying things : boys, for example, will enjoy designing sets for historical plays ; girls can cut out flat cardboard models of women and babies, and clothe them with flat paper costumes, sketched and coloured to their own fancy or to illustrate local or historical dress.

All the home industries that involve handwork should be

freely encouraged—the making and mending of simple household articles of every type. With the boys, the woodwork, metalwork, and leatherwork should include, so far as possible, the countless little jobs that a handy husband might be called upon to carry out in the home. With the girls, dressmaking, cookery, and other subjects of domestic economy will have their proper place. Domestic training can often be given most effectively by arranging that, for certain spells, each girl has her own separate task, changing over at the end of a month or term. Instruction on personal hygiene and infant hygiene will be essential for all. The younger girls should have definite lessons in home-management—how to lay a table and to serve at meals; how to dust and sweep a room; how to clean windows, cutlery, brass, and plated goods; and, later, how to shop and keep household accounts. Sewing should include the darning and repair of old garments as well as the construction of new. Cookery should include, in addition to the usual practical lessons, simple instruction on foods and their respective values.

Among the older girls, however, many take a dislike to what they call housework—lessons that seem a mere repetition of tiresome tasks imposed on them at home. With them something more constructive or decorative will arouse a keener interest. They often take willingly to rug-making and weaving on hand looms; and simple work in cane and clay-modelling may be made to lead up to basketry and pottery, which nearly all enjoy. Coil pottery can be attempted to begin with. Later, the colour-box can be introduced; the pots can be tinted, decorated, and varnished, and the finished articles fired in a gas oven.

By these different means the children will learn to be useful in their future homes in numerous little ways—from patching clothes and repairing pots and pans to providing articles for use and ornament. At the same time they will become acquainted with the chief mechanical and scientific properties of everyday objects and everyday materials. Above all, it is through these more practical channels that reading and writing, spelling and arithmetic, should be chiefly taught and practised.

(*c*) *Concrete.*—Quite apart from handicraft, much instruction may still be conveyed in concrete form. As we have seen, one striking difference between the dull child and the normal lies in the incapacity of the dullard to deal with abstract ideas and relations. But when he is given his problem in the concrete, his power of reasoning will often come as a surprise. Keep him, therefore, in close touch with concrete situations and materials. Appeals to the ear should be supplemented, or even supplanted, by appeals to the eye and the muscle sense; mere listening and answering, mere work with the printed or the written page, by actual seeing and doing. Madame Montessori has shown how the elements of the formal subjects may be acquired, and the use of the senses and the muscles trained, by the provision of special didactic apparatus. Many teachers have carried these principles further by the invention of fresh devices of their own. And much still remains to be done in this direction for older and backward children on lines already established for the young and the defective.

Pictures and models—often made by the older children—can be freely used in teaching the younger. The cinematograph has enormous possibilities for the instruction of this type of child. Where moving pictures cannot be shown, the ordinary projection lantern may still be of service. Broadcast lessons have hitherto proved somewhat unsatisfactory for duller pupils, except at the older ages; but here there is room for further experiment.

Nature studies should occupy an important place in the curriculum. Almost every school can find room for a small made-up garden. But the children should be encouraged to take an intelligent interest, not only in plants, animals, common substances, and the changes of the weather, but also in the features, the activities, and the history of their own immediate neighbourhood.

(*d*) *Industrial.*—For the older pupils particularly, much of the teaching might have a definitely utilitarian aim, and be specifically adapted to their probable future employments. The aim of such work will be, of course, not so much to teach the child a trade, as to teach him to take an intelligent interest in his (or her) future work, whether in or out of the

home. Indeed, with the older pupils the subjects of the curriculum should largely be selected with an eye to local industries. But, whatever be the child's trade, he will at least be a citizen, and probably a parent.[1] Boys, therefore, should know something of civic problems and civic duties. Girls may be definitely trained with an eye to domestic and maternal offices. The sex restriction might even be abandoned: interest the boys in the home and the girls in the State. These are matters to which the school must give deliberate attention, since the dull, unlike the normal, cannot be expected to pick up correct ideas and methods for themselves.

(*e*) *Culture.*—Cultural subjects should not be neglected, but should be adapted to the children's interests, capabilities, and special gifts. Many of the backward are also unstable; and, if they are to form steadier habits of conduct and higher ideals of life, they will need something more than a scheme of education concerned solely with practical and utilitarian interests. Virtue in the abstract will mean little to them; and vague moral arguments will nearly always fail. But they are capable of fine personal loyalty, of keen enthusiasm for what has an intelligible and concrete appeal, and of sociable co-operation with others on a more or less humble plane. Always, however, their conduct will be swayed more by emotion than by thought. For them, training for leisure will be of special moment; and the endeavour to implant enlightened emotional interests will do much to prevent the lower outlets for emotion from offering the sole channel for self-expression and

[1] In passing, we may point out that if, as we have maintained above, a large proportion of the mentally deficient arise simply as a result of the wide variation in native intelligence among the general population, then it follows that the dull and backward, being nearly seven times as numerous as the mentally deficient, are likely—when it comes to parentage—to form the group that will be responsible for the largest number of mentally defective children in the following generation. Many, therefore, would argue that education for parenthood should include instruction upon the supremely important problem—when parenthood should be avoided. Whether scientific knowledge and public opinion are at present sufficiently advanced for popular instruction on these lines is, however, a question that cannot here be discussed.

self-enjoyment. Often they are by no means backward in artistic appreciation. Poetry and the English classics are usually, though not always, beyond them. But they are, as a rule, responsive to music in every form, especially when allowed to take an active part in it : the enjoyment of good music has almost as much cultural value as the enjoyment of good literature ; and stories and selections from Wagner would be no more above their level than stories and selections from Shakespeare.

Dancing and dramatic displays always appeal to backward girls ; and they might well be taught folk-dancing in the schoolroom before they take to jazz outside. With the younger children of both sexes rhythmic and eurhythmic exercises to music will not only strengthen and co-ordinate bodily movement, but will do much towards steadying and co-ordinating emotion and character. Æsthetic and expressive work, being concrete, are within the reach of nearly all, and may provide a useful means of simple intellectual culture. Many have vivid imaginations—crude, but capable of training. Drawing, brushwork, and the appreciation of pictures may therefore figure largely. Taste may be cultivated by giving the child opportunities for spontaneous designing, especially with coloured materials—as for instance in stencilling or in fancy needlework. Often the child's own efforts at pictorial illustration may supplement, or be supplemented by, his attempts at written composition. For many, silent reading is easier than reading aloud ; and where they cannot read themselves, they may still be read to with profit.

Although self-expression on paper is gravely hampered by the mechanical difficulties of writing and spelling, these children are often able to express themselves orally as well as through material media. Oral composition, particularly in the form of spontaneous acting and debates, should therefore be systematically encouraged. Develop the child's ability to talk freely and naturally. There is no need for pedantic insistence on a grammar, vocabulary, or pronunciation that are absolutely correct. Such endeavours are not only bound to be futile in the end, but may incidentally attach an unfortunate sense of intellectual or

social inferiority to the dialect, idiom, and diction which the child spontaneously employs.

We have seen that the essential characteritics of the dull child, when examined with the usual tests of intelligence, is that he fails most conspicuously of all in the various processes of reasoning. How to deal with this deficiency as it affects ordinary school subjects, like composition and arithmetic, I have already discussed. But with the dull child the acquisition of sound methods in numerical calculation or in English composition is a matter of minor importance. The essential thing is to teach him logical habits which will operate when he deals with the more practical issues that will confront him in after-life—to lead him, if possible, to see both sides of every question, to discount the unconscious influence of his personal interest and private prejudices, to resist the suggestive dominance of commercial advertisement, political oratory, and popular superstition, and to substitute a scientific attitude for one of emotional suggestibility. It is a grave psychological mistake to suppose that, if he has had regular practice in the solution of simple sums, he will later on spontaneously apply the same rational principles when he argues with his friends or with his wife over the choice of a job, the rights of a workman, or the causes of the baby's ailments.

Accordingly, instead of trying to drill an alleged faculty of reasoning through highly abstract activities, like problem work in arithmetic, it will be better to elicit the child's sense of what is rational by setting him simple logical exercises on concrete topics more within his own natural interests and powers. All children are fascinated by detective stories; and with many a good training in reasoning can be provided by putting before them, as concretely and vividly as possible, intriguing problems with the necessary data, drawn from the exciting events of the world around them, and then encouraging them to work out their own solutions by means of systematic argument. A dunce who fails hopelessly at simple rule of three will often guess the key to a Sherlock Holmes mystery or a film drama when the plot is only half unfolded. And from this he can be led on to more rational ways of thinking out the

social and economic questions that are bound to confront him as a worker, a housekeeper, and a citizen.[1]

Time-tables.—In order to make room for the newer subjects and these novel methods of instruction, much that is traditional in the ordinary curriculum may be scrapped without scruple. Dispense with all that neither appeals to the natural interests of the child himself nor bears closely upon his work or leisure in after life. The notion that useless or uninteresting exercises may yet prove valuable as a mental gymnastic is nowadays held to be an outworn superstition. Accordingly the child need never be taught to spell words that he is unlikely to use, simply 'for the sake of practice'; he need never be taught to work out sums dealing with measures or processes he is never likely to require, simply on the ground that 'arithmetic provides the best discipline for the mind.' In memory work—for example, in learning arithmetical tables—extra drill may at times be usefully introduced. But the sole object of such drill will be to drive home particular facts, not to strengthen a weak memory, since, so far as we know, that can never be done. At bottom, as I have repeatedly argued, most of the learning of which the dull child is capable will be found to resolve itself into the acquisition of habits—habits of action that we call skill, and habits of thought such as we call memories.[2]

[1] A kindly critic has accused me of inconsistency in maintaining, first, that 'tests of reasoning effectively measure innate intelligence' and, secondly, that 'reasoning itself is a teachable technique.' The evidence for the former statement I have given in an early article (*Journ. Exp. Ped.*, 1919, V, ii, p. 72); the evidence for the latter rests partly on my own experience in coaching backward children and partly on the results of several teachers who, at my suggestion, attempted to train small classes with simple logical problems and were able to demonstrate that, if logical rules were taught as conscious principles, capable of universal application, and an ideal of good reasoning systematically inculcated, the normal child, and to a less extent even the dull, showed a definite improvement in accuracy of thinking, not only in school work (*e.g.*, composition), but also in conversational discussions. Possibly one explanation of the apparent paradox is that, although reasoning is teachable, it is not as a matter of fact successfully taught. But I believe further research will also demonstrate that there is an insuperable psychological distinction between what is and what is not teachable with children of a given intellectual level.

[2] I have endeavoured to summarize, from an educational standpoint, the

In arranging the school time-table the old lines of demarcation between one subject and another may be dropped or cut across. There need be no English lesson for the child to learn English, no arithmetic lesson for him to learn arithmetic : he will learn both incidentally in the course of work of a more concrete and attractive character. Since, as we have seen, the dull child is more quickly fatigued by any kind of task that calls for sustained intellectual effort, the spells of work should be shortened. This does not mean that in the time-table there should be more frequent changes from one lesson to another. On the contrary, jumping about from this topic to that will generally increase both bewilderment and mental strain. All that is necessary is that the explanations, the formal exercises, the incidental drudgery, should be abridged. So soon as a child's interest begins to wane and his attention seems to flag, vary the type of work and try a fresh form of appeal.

Throughout, both topics and methods of instruction should be correlated as intimately as can be with the different interests and activities that emerge spontaneously at each period of the child's development. As much as possible should be made of the natural curiosity that is continually aroused by out-of-school experiences, and of the fragmentary knowledge the child has already gained for himself—knowledge about shops and their commodities, about roads, railways, and places of public interest, about the commercial and industrial undertakings of his neighbourhood, about the educational, postal, hospital, tram, bus, police, and fire-brigade services of his town, and the like. By starting from this basis, and developing

psychologist's conclusions on ' mental discipline ' in a paper on *Formal Training* drawn up for a committee of the Education Section of the British Association (*Annual Report*, 1930, pp. 279 *et seq.*). But there is still room for further psychological research both on the feasibility of improving weak abilities, or at any rate weak habits, by specially devised methods of drill, and on the degree to which, and the conditions under which, the effects of training generally are transferred with the dull as distinct from the normal. Broadly speaking, the dull seem far less apt at spontaneously applying what they have learned ; and the transfer has to be expressly suggested and assisted by the teacher. With them what may be termed 'incidental learning' is far more rare, slow, and uncertain than with the normal.

what little the child has picked up, much of the general information that would be supplied in a better home can be given in school; and a way can thus be paved for bringing a concrete significance into more purely scholastic lessons.

Since backward children differ from each other far more than normal children, the arrangements of the class should be planned so as to permit independent lines of work. Spontaneous movement and activity should be cultivated rather than repressed; and a good deal more talking may be allowed amongst the children themselves—at any rate at certain periods—than is usually countenanced in an ordinary classroom. Co-operation with others should be vigorously encouraged; and the child should learn to associate easily, not only with other members of the backward class, but also with those who are intellectually superior to himself.

All this implies that, in arranging the time-table for the backward, thought and attention must be concentrated more on organizing activities to suit the class than on organizing lessons to suit the syllabus, more on the allocation of work to the individual pupils than on its allocation to successive periods of the day. I suggest, therefore, that *the curriculum be planned in terms of projects rather than of subjects.* The projects will be concrete tasks or topics, arising out of the child's natural interests and daily life—'our food,' 'our health,' 'our neighbourhood,' 'Christmas,' 'transport,' and the like—each embodying a more or less definite aim, and each ingeniously devised so that the next steps in knowledge and skill will be taken in their turn, until the whole of the ground, mapped out as appropriate for the age and intelligence of the class and its various members, has ultimately been covered. There should be projects for the individual, projects for little groups of two or three, and projects for the whole class; and the class master or class mistress will act, not merely as a teacher, but also as a tutor. The general principle is not unlike that adopted for teaching University students in a psychological laboratory: in addition to the collective lectures and the practical classes which all attend, the students are subdivided into pairs or trios, and set to carry out experiments according to

a systematic scheme or to get up subjects in the library for discussion at a seminar; isolated students are further assigned private pieces of research, the problems often being suggested by the students themselves and involving sometimes practical work in the laboratory, sometimes book-work in the library, and sometimes visits outside the college walls to schools, to clinics, or to other places of interest. Strange as it may sound, all this can be attempted even with a backward class. Experiments recently made in London schools show that, given an enterprising and enthusiastic teacher, the children's progress under this plan is far greater, even in the formal subjects, than with the old method of continuous collective lessons at set periods.[1]

Incentives.—Perhaps the most essential requisite of all is

[1] There is a vast literature on these novel methods of organizing classroom work; but most of it has reference to normal or secondary school children rather than the dull and backward. The so-called 'Dalton plan' is perhaps the most thoroughgoing embodiment of the principle of individual work (see Helen Parkhurst, *Education on the Dalton Plan*, 1922; C. W. Kimmins and B. Rennie, *The Triumph of the Dalton Plan*, 1927; C. Washburn (author of the 'Winnetka plan'), *Adjusting the School to the Child*, 1932). The 'project method,' at any rate as carried out in America, places more emphasis on social co-operation (see W. H. Kilpatrick, 'The Project Method,' *Teachers' College Bulletin*, October 1928; also C. M. Fleming, *Individual Work in Primary Schools*, 1934). What is here suggested is a combination of the merits of both with those of traditional class-instruction and discipline. From the backward it is useless to expect the same amount of initiative and self-reliance as may be elicited from the bright: but at the same time with them such qualities need even more urgently to be developed. The experience of the 'Hamburg experiment' is suggestive: nowhere, I suppose, has such freedom been accorded to school pupils as in the schools that were re-modelled under its influence. But within a few short years one of the teachers in the forefront of the movement issued a book with the significant title *Die Wiederentdeckung der Grenze*—'the limit rediscovered.'

In a later volume I hope to take up the problem of special disabilities in the separate school subjects—reading, spelling, arithmetic, and the like—and this will enable me to give more detailed suggestions in regard to syllabus and teaching devices. On the general problem the teacher may usefully consult the following: D. Kennedy Fraser, *Education of the Backward Child* (1932); A. D. Inskeep, *Teaching Dull and Backward Children* (1932); H. S. Wyndham, *Ability Grouping* (1934); H. R. Hamley and others, 'The Education of Backward Children' (reprinted from *The Year Book of Education* for 1936); and *The Practical Senior Teacher* (1933, esp. the section on 'The Backward Child,' pp. 73 *et seq.*).

a constant appeal to effective motives. The normal child is expected to find a motive for himself: it is his duty to work as his teacher requires, and that (it is commonly assumed) should be sufficient. The duller child needs a cruder and more concrete stimulus. Half the problem of keeping the backward intellectually active consists in discovering right incentives. Whatever the child is set to do must embody some obvious purpose—a purpose in which he is interested and which his intelligence can readily grasp. If a girl is told to multiply, it must be to multiply with a reason—to discover how much it will cost to make a frock or jumper for herself with such and such materials; if she is to read, it must be to discover how to cut out the pattern, or how to alternate the stitch, or it may be to learn the end of an exciting story. Lack of application means usually lack of a driving impulse. So far as possible, explore the mental background of each individual child; find out what thrills him most, and take that as the starting point for more serious tasks. Give the peculiar interests and aptitudes of every individual full scope to develop and show themselves, how they will and when they will, even at the cost of order and routine. I am, indeed, tempted to suggest that the classroom for the backward should be not only a workroom, but also, within reasonable limits, a playroom: for certain short periods of each day the opportunities for self-expression and observation—free self-expression by the child, unobtrusive observation by the teacher—which have been so successfully developed in dealing with subnormal children in the clinic playroom might be introduced into the school. Never be content with discovering merely where the child is weak and backward. Make the most of each one's strongest points and compensating aptitudes. The dull child will have failed so often that he will always be expecting to fail again. Give him something at which he can succeed, and keep him happily as well as usefully occupied. Avoid reproaches, and remove the ingrained sense of failure by giving him some special kind of work in which he can quickly achieve a conscious improvement and taste the triumph of a personal success. Never let the child lose heart: for once he has lost heart he has lost everything.

Need for Co-ordinated Research.—Finally, one of the most urgent of all immediate measures is indicated by the general lack of detailed and trustworthy knowledge upon the whole problem of the backward and the dull. These children have their own special requirements, and present their own special difficulties, quite as much as the mentally deficient; but they have not as yet been studied to anything like the same extent. Certainly it is now well recognized that the teacher is not necessarily, nor even primarily, to blame if his pupils are behindhand. Yet teachers are themselves among the first to recognize their own shortcomings. Where then can we send the eager inquirer who asks for more explicit information and guidance? The literature of the subject is meagre and often unscientific; the instruction given in training colleges and in special courses of lectures is bound to be incomplete because, after all, but little systematic investigation has hitherto been undertaken.

The time has certainly come for some co-operative scheme of research into the innumerable questions that arise. A single investigator can do little, except make a few limited and tentative experiments, and sketch what appear to be the most valid methods of inquiry. The teacher, the medical officer, the social worker, the psychologist, the inspector, and the statistician—all need to lend their expert knowledge; but each can deal only with one limited aspect. Accordingly, it might well be urged that some competent body, such as the Board of Education, should set up a consultative committee to explore the whole situation. Once established, such a committee would immediately stimulate teachers and educational authorities to give special attention to the question, and might lay down general lines which experiments could usefully follow. Individual enterprises, unco-ordinated and sporadic, can do no more than first break the ground. Again and again I have been struck, in the course of my investigations, with the large number of isolated teachers who, entirely upon their own initiative, have already formed backward classes within their own schools, carefully elaborated suggestive schemes of work, hit upon ingenious devices for practical teaching, and have even amassed records and data of unique

interest and utility. Frequently the very existence of these attempts is unknown to the authorities themselves. Conditions change ; a new headmaster arrives ; or the classroom is required for a bigger group. The backward class is thereupon dispersed, and the whole experience lost. Yet many of these first-hand experiments might serve as a model for other teachers, and a few perhaps as a warning. Whatever results are achieved in these directions might well be collected and collated, the efforts extended on some systematic plan, and the knowledge gained by each placed at the disposal of all.[1]

[1] Since the earlier edition of this volume was issued, an inquiry has been carried out into the kinds of educational reform most urgently needed. The inquiry was commenced under the auspices of the Home Intelligence Division of the Ministry of Information some months before the recent Education Bill was due for presentation (under the title ' An Inquiry into Public Opinion regarding Educational Reforms,' an abridged account has been printed in *Occupational Psychology*, XVII, pp. 157–67 ; the replies to the questionnaire on curricula, child guidance, and special schools and classes have been summarized more fully in a privately circulated Report). Among the numerous changes and reforms they advocate, many teachers include ' better provision for the dull and backward.' However, when desired to rank the suggested changes in order of priority, this particular item was ranked only sixteenth by teachers, eighth by school medical officers, and seventh by educational psychologists. The types of provision most frequently mentioned were the establishment (i) of special classes and (ii) of psychological clinics. Ten per cent. held that the chief need was for special schools ; 43 per cent. preferred special classes within the ordinary school ; 18 per cent. argued that the dull and backward do best if educated in the ordinary class. As regards clinics, the majority of teachers advocated psychological ' centres ' (as many prefer to name them) set up by the local education authority under the direction of an educational psychologist with teaching experience ; the majority of the school medical officers advocate clinics with a medically qualified psychiatrist as director ; other members of the medical profession, however, strongly criticize the present training and qualifications of psychiatric specialists (somewhat on the lines taken by the Goodenough report) ; teachers and psychologists criticize rather the lack of knowledge of educational psychology and its problems which they say is shown by many of the psychiatrists. It seems plain that there is a pressing need for all who are interested in the problem of the backward child—whether from the educational, social, or medical standpoint—to consult each other and compare their respective views and experience, and so evolve co-operative principles of action on a basis of mutual understanding, and a more appropriate scheme of training for psychologists, psychiatrists, social workers, and others taking part in such work.

APPENDIX I

SCHEDULE FOR CASE-RECORDS

There is no one detailed scheme for recording data about school children which will serve all purposes. In dealing with backward pupils, at least two types of record may be required: first, the cumulative record which the teacher should keep at the school, both for his own guidance and for that of others who may have to deal with them later on; secondly, the records compiled by the psychologist for those cases referred to the child guidance centre: these will enable him not only to report on the individuals as he sees them, but also to undertake reviews of his work as a whole.

As the reader will perceive, many of the conclusions set forth in this volume, tentative as they are, were nevertheless rendered possible only by a statistical examination of case-records compiled at what was, in effect, the first child guidance centre established in this country—the office of the psychologist in the education department of the London County Council. But there is an urgent need for such investigations to be repeated and extended. Again and again research-workers, often coming from abroad to study our methods of child guidance, have desired to analyse case-papers, or to follow up the after-histories of the pupils referred to clinics, in the hope of studying the efficacy of different kinds of treatment or training. Unfortunately (as the Directors themselves have usually pointed out) the clinic records, though useful enough for immediate purposes, are generally of little value for scientific study.[1]

[1] In their replies to the Ministry of Information questionnaire on educational reforms, several departments of psychology and education stressed this point. An experienced director of education replied: 'In a work on child guidance by a medical director of a clinic I read that, "since child guidance has been developed into a branch of medicine, it has become more scientific in its methods and more accurate in its results." I therefore visited several clinics, inquiring about studies of methods and results, before organizing child guidance centres of our own. I was astonished at the lack of any scientific plan. All senior educational psychologists should have not only a practical training, but also a training in scientific method.' An eminent psychiatrist observes: 'There is a tendency for practical therapy to get divorced from the more academic aim of research. A physician feels that his first duty is the practical treatment of his cases, not the theoretical study of his science. Indeed, if he is to inspire confidence in his patients or their parents, any scientific doubts about the accuracy of his assumptions must be severely repressed. Hence the tone of assured conviction with which we doctors are apt to generalize on the basis of personal impressions and experience, until we feel that research is really waste of time.' I fear the teacher is himself not always free from the 'pedagogue's *uberrima fides*.'

The scientific training and treatment of subnormal children is a new and growing branch of education. Every child guidance centre, therefore, should be planned for carrying out research on these general problems, as well as for giving immediate assistance to the individual child. And in working out a suitable scheme for his case-records, the psychologist at the clinic would do well to profit by the experiments of others who have initiated work along similar lines in the past.

The first to urge that schools and educational institutions might form useful centres for psychological research was Francis Galton. 'As every hospital fulfils two purposes, the primary one of relieving the sick, and the secondary one of advancing the knowledge of pathology, so every school might fulfil, not only that of educating boys, but also that of promoting directly the science of education. If the schoolmaster were able and willing to codify in a scientific manner his vast experience of boys, to classify their temperaments and intellectual qualities, and generally to describe them as a naturalist would describe the fauna of some new land, what excellent psychological work might be accomplished.' [1] And Galton's very practical schemes for compiling scientific case-records are still worth studying. His guiding principle was to set down in quantitative terms assessments of a small number of regular key-qualities, and build up the detailed descriptions around these. In order to avoid overlapping, these chosen characteristics were to be so far as possible uncorrelated; and in order to facilitate practical deductions, each was to be correlated with a maximum of unrecorded items. Thus, 'the art of measuring the physical and mental faculties of human beings should enable a shorthand description of any individual to be given by recording the measurements of a small selected sample of his qualities or dimensions.' [2] This search for appropriate 'dimensions' has formed the aim of what is now technically known as 'factor-analysis.' [2] And indeed, the classification of the chief causes of backwardness (and, it may be added, of mental subnormality generally) is—or, in my view, should be—largely based on, and checked by, factorial studies.

The schemes I myself have developed were in the first instance suggested by those used by Galton and his fellow-workers at the Anthropometric Laboratory, University College. They have been greatly modified from time to time, partly as a result of obser-

[1] 'Proposal for Anthropological Statistics from Schools,' *J. Anthr. Inst.*, III, 1874, pp. 308 *et seq.* Cf. *Nature*, XXII, 1880, p. 9.

[2] 'On Anthropometry in Schools,' *Report of Congress of Public Health*, 1905. The term 'psychometry' was introduced by Galton to cover the assessment of psychical qualities. As regards methods of factor-analysis, those planning researches of their own may refer to Appendix III below (pp. 674 *et seq.*) and the references there given.

vation and experience and partly by factorial inquiries and other psychological analyses. The general outline thus reached has already been published elsewhere, and need not be repeated here (cf. p. 601 above, footnote 1).

There is, however, one important item which I should like to emphasize—that which is labelled ' Environment.' The insistence of Galton and Pearson on the primary need for determining innate or inherited traits has tempted many British psychologists to neglect ' nurture ' in their concern with the limitations imposed by ' nature.' But the two interact like seed and soil. In *The Young Delinquent* I have already devoted two long chapters to the influence of ' social conditions.' Hence it seemed unnecessary to cover the same ground in the present volume. Nevertheless, since in the case-reports [1] received from child guidance clinics I find both psychologists and psychiatrists often overlooking this type of psychological influence, I venture to suggest that special attention should be drawn to them in practical training-courses given at the University or elsewhere. The need for such studies was brought home to me most forcibly in the early days of my work. I myself endeavoured to get some inside knowledge of the different social backgrounds of the general school population by residing at settlements in the slums and by seeking week-end invitations to the homes of dock-labourers and other unskilled workers in different parts of London. The flood of new light thrown on backward or delinquent pupils by this new knowledge has led me always to urge my own students who are entering the field of child guidance, to obtain a similar experience for themselves.[2]

[1] The reports of psychiatric social workers show a marked advance over the earlier reports of care-committee workers, which dealt almost exclusively with economic and sanitary conditions. Yet, because their interest is primarily ' psychiatric,' they are prone to look chiefly for abnormal conditions, or to interpret what is really normal in the child's own circle in language drawn rather from the writings of psychopathologists than from those of sociological observers. It is indeed singular that British psychologists and psychiatrists have paid so much attention in their writings to the culture-patterns of Polynesian tribes and to psychoanalytic speculations about totems and taboos, and have as yet carried out so little systematic first-hand observation on the primitive customs and traditions characteristic of different social groups in their own country. Degree courses for students of psychology still spend far more time on ' coming of age in Samoa ' than on ' coming of age ' in Shoreditch or on the Merseyside.

[2] In a recent letter discussing my suggestion that the psychologists proposing to work at child guidance centres should obtain a first-hand knowledge of the home and out-of-school environment of the children they are likely to meet, Dr. McCluskie replies that ' the psychologist is much too specialized for this : only an experienced general practitioner knows sufficient of the intimate life of the people to make a good child psychiatrist ' (*Brit. Med. Journ.*, No. 4501, p. 508). And more recently he has argued that ' the educational psychologist, though far ahead of the psychiatrist in the technical skill of his profession, is nevertheless quite unfit to appreciate more than the surface of parental problems ' (*Brit. Med. Journ.*, No. 4507, p. 739). As the son of a general practitioner, I myself profited greatly by the interest and experience I obtained in that way ; but I doubt whether the average general practitioner of these modern days is so familiar with the home conditions of the poor as Dr. McCluskie supposes. And how many psychiatrists at child guidance clinics have sought their

In drawing up the scheme for the record-form below, I have had in mind the teacher working in the backward class rather than the educational psychologist working at the child guidance centre. Hence, certain sections are comparatively brief. Otherwise the scheme may serve as a modifiable basis for both purposes. I should, however, like to urge the importance of keeping a special progress record for the class as a whole. This should cover, not merely its general intellectual achievements from week to week and from term to term, but also the changes in the emotional attitudes and inter-relations of its component members. Such a study is particularly helpful when the work of the classroom is organized on comparatively free lines, and aims at imparting a social as well as an intellectual training.[1]

RECORD-FORM FOR RETARDED CHILDREN

Name (surname first in block letters, and Christian names)......

Age..............$\frac{}{12}$ *Date of Birth*......................

School..

Address...

I. Family History

Father	Mother	Brothers and Sisters	Grandparents and Cousins
....	....	....	....

preliminary training along these lines ? In their writings they commonly interpret child-and-parent relationships in terms of those obtaining among the fee-paying middle classes : nor can I recall any medical book or article on child guidance that analyses home influences on the basis of first-hand knowledge, though psychologists' contributions are full of such descriptions. Finally, Dr. McCluskie's statement that 'the psychologist is much too specialized' suggests that (like so many critics of academic courses in psychology) he is quite unaware of the broad basis for practical training laid down in the working syllabuses which a modern department of psychology seeks to implement (*e.g.* that which forms the programme of work in the University of London's postgraduate diploma in psychology).

[1] As I have argued in the text, where incentives and character-development are concerned, the influence of the pupils on each other is as great as that of the teacher. Hence the methods which I have described elsewhere for the study of moral progress in delinquent colonies may be helpful even with day pupils in the classroom. At Riverside Village we kept an 'orrery' showing, in the form of a psychological star-map with marginal comments, the mutual attractions and repulsions of the several human constellations, satellites and stars, the wandering planets, and the aberrant comets, all revolving round the central luminary (the Warden himself), and forming changing patterns of equilibrium within the field of emotional forces formed by their personal likes and dislikes. The gradual advance towards final stability, the hidden obstacles and incentives, were thus clearly recorded ; and grounds for occasional providential interventions plainly revealed.

Enter, for each of the above—

(i) Age (state if dead).
(ii) Occupation (note economic inefficiency, pauperism, etc.).
(iii) Health (note constitutional or nervous ailments of a hereditary character).
(iv) Mental status (note backwardness, mental deficiency, insanity, criminality, illiteracy, and milder defects of intelligence, education, temperament, and morality).
(v) Miscellaneous points (race, consanguinity, step-parentage, illegitimacy).

II. Home Conditions

(i) Family income........ Rent........
(ii) Number in family living at home.
(iii) Housing conditions (type of street, number of rooms, sanitary condition, cleanliness).
(iv) Home supervision and discipline (facilities for instruction and recreation at home; co-operation with school; general attitude of family towards child).
(v) Condition of child in regard to clothing, footgear, home-feeding, and cleanliness.

III. Physical History

(i) Conditions of pregnancy and birth.
(ii) Age of walking, talking, cleanliness, teething, menstruation or breaking of voice, and pubescence.
(iii) Illnesses (including constitutional defects, malnutrition, rickets, fits, congenital syphilis, encephalitis lethargica, infectious and nervous diseases, etc.; accidents or injuries—with special reference to severity, loss of school attendance, and apparent after-effects in each case).
(iv) Reports of previous medical inspections.

IV. Physical Examination

(*A*) *Anthropometric*

(i) Physical development: height...... weight......
Other measurements (*e.g.* head...... chest......).
(ii) Tests of sensory capacities:
Vision: R. ...... L. ......
Hearing.
Other measurements (*e.g.* touch, muscle-sense).

(iii) Tests of motor capacities (muscular strength, speed, and precision).

(*B*) *Medical*

(i) Physiognomy and general appearance; deformities; stigmata.
(ii) Nutrition.
(iii) Skeletal conditions (rickets, scoliosis).
(iv) Muscular conditions: posture, gait, paralysis, tremor, choreiform movements.
(v) Nose and throat: defective nasal or palatal formation, enlarged tonsils, adenoids, mouth-breathing, snoring, otorrhœa, catarrh.
(vi) Speech (defective articulation, lalling, stammering, etc.).
(vii) Other defects (heart, lungs, digestive organs).
(viii) Uncleanly habits (incontinence, salivation, masturbation, etc.).

V. Psychological Examination

(*A*) *Mental Tests*

(i) General intelligence:

Mental Age (M)	....
Actual Age (A)	....
Mental Ratio $\left(\frac{M}{A} \times 100\right)$	....

(ii) Special abilities or disabilities (attention, observation, quickness, manual dexterity, linguistic ability, memory, imagery, association, reasoning, etc.).

(*B*) *Educational Tests*

(i) Standard reached ...... (equal to work of this standard).
(ii) Attendance.
(iii) Mental age for reading, spelling, composition, arithmetic, writing, drawing, handwork, and other subjects.
(iv) Subjects preferred and disliked.
(v) General knowledge and interests.
(vi) Reports of head- and class-teacher, with special reference to the child's habits and methods of work.

(C) *Temperament and Character*

(i) General emotional energy and stability.
(ii) General type (repressed and sensitive, or unrepressed and excitable; cheerful, or unhappy).
(iii) Development of special instincts and emotions (appetite, sex, anger, fear, wandering, acquisitiveness, assertiveness, submissiveness, curiosity, disgust, affection, sociability, talkativeness, cheerfulness, sorrow).
(iv) Neurotic symptoms (walking or talking in sleep, dreams, nightmares, phobias, headaches, fantasies, day-dreams, excessive fatiguability, hysterical manifestations, etc.).
(v) Personal and social qualities (general bearing, personal appearance, personal habits, mannerisms, self-control, self-confidence, co-operation, attitude towards other children (older, younger, same age), leadership, strength or weakness of will, initiative, industry, honesty, punctuality, etc.).

VI. Summary or Diagnosis

(*e.g.* dull, backward, mentally defective, unstable, neurotic, delinquent, partly deaf, visually defective, physically handicapped, socially handicapped).

VII. Measures Recommended

(i) Medical.
(ii) Social.
(iii) Scholastic (special school, special class, individual schemes of work).
(*a*) Immediate aims or needs: *e.g.*
Knowledge (in terms of educational tests);
Habits of work;
Social readjustments.
(*b*) Special teaching methods.

VIII. Subsequent History and Progress

Educational attainments.
Vocational aptitudes.

APPENDIX II

CURVES OF GROWTH

A. Norms for Physical Development

In Table XXXI I give the average height and weight of normal, backward, and mentally defective school children in London at each age of school life. The age shown in the first column is age last birthday: 'age 4-' therefore includes all children between 4 yrs. 0 mths. and 5 yrs. 0 mths., thus averaging 4½ years. Height was measured without shoes; weight without shoes, but with indoor clothes (about 5 per cent. of gross weight). By 'normal' children is to be understood children attending the ordinary elementary schools (including the backward); by 'mentally defective,' those attending special (m.d.) schools. The figures differ but little from the 'norms' given in my preliminary report to the London County Council,[1] but at almost every age are appreciably higher than those obtained some thirty years ago.[2]

My impression is that, in the poorer districts, from which, after all, the bulk of elementary school pupils is drawn, the measurements must have risen rather rapidly after the introduction of a systematic medical service, and that they are probably still rising, but that in the better-class districts the change has been comparatively small. There can be little doubt that, assuming no further abnormalities in social and economic conditions, the norms will again have to be slightly raised in the near future. The local differences are considerable: about the middle of their school life, children from the better-class suburbs situated on the higher ground to the north and south of the county are nearly 2 cm. taller and 2 kg. heavier than those living in the low-lying, poverty-stricken areas along the Thames. Outside the county, the averages vary still more widely; hence each educational area should compile its own set of norms, and revise them from time to time.[3]

The use of tables for assessing the physical development of

[1] *L.C.C. Report on The Distribution and Relations of Educational Abilities* (1917), p. 88.

[2] *L.C.C. Report: Medical Officer* (*Education*, 1909), p. 13.

[3] Some notion of the local differences can be obtained by studying the collection of tables published in Arthur Greenwood's *Health and Physique of School Children*.

individual children has already been discussed in Chapters VI and VII (pp. 155–8, 174–8). But, quite apart from direct applications for this purpose, such figures are of theoretical interest to the psychologist for several reasons: they throw considerable light on problems of human growth, and, in particular, suggest analogies for analysing, predicting, and allowing for, changes due to mental development.

TABLE XXXI. AVERAGE HEIGHT AND WEIGHT OF NORMAL, BACKWARD, AND DEFECTIVE CHILDREN AT EACH AGE

BOYS

	Height (Cm.).				Weight (Kg.).			
Age.	Normal.	Standard Deviation.	Backward.	Defective.	Normal.	Standard Deviation.	Backward.	Defective.
4-	98·0	4·7	[95·9]		16·1	1·8	[15·3]	
5-	103·4	4·9	[101·2]		17·2	2·0	[16·6]	
6-	108·7	5·1	[106·3]		18·7	2·3	[17·8]	
7-	114·4	5·7	111·4	110·9	20·8	2·7	19·7	18·8
8-	119·8	5·0	117·6	115·0	22·7	2·8	21·3	21·2
9-	124·7	5·4	122·5	121·7	25·5	3·4	24·0	23·8
10-	129·2	6·1	127·2	125·2	27·6	3·0	25·4	25·9
11-	133·7	6·2	131·8	130·1	29·6	3·5	28·3	29·0
12-	138·8	6·5	135·9	134·7	31·7	4·3	30·4	30·6
13-	142·6	7·1	141·0	140·5	34·7	4·9	31·4	33·1
14-	148·1	8·0	[146·3]	144·3	38·4	5·6	[37·3]	36·3

GIRLS

	Height (Cm.).				Weight (Kg.).			
Age.	Normal.	Standard Deviation.	Backward.	Defective.	Normal.	Standard Deviation.	Backward.	Defective.
4-	96·9	4·6	[94·5]		15·8	1·6	[14·9]	
5-	102·7	4·5	[100·2]		17·0	1·8	[16·3]	
6-	107·5	4·9	[105·1]		18·6	2·1	[17·7]	
7-	113·8	4·9	111·1	109·3	20·5	2·4	19·6	19·1
8-	119·1	5·1	116·2	115·2	22·7	2·7	21·5	20·9
9-	123·6	5·5	121·5	119·4	24·6	3·3	23·2	23·0
10-	128·7	6·8	126·3	125·8	26·8	3·1	25·8	25·6
11-	134·2	6·7	131·4	127·7	29·7	4·5	28·7	28·2
12-	139·7	7·2	137·0	134·3	33·4	4·9	32·4	32·5
13-	145·1	6·8	142·3	141·8	36·6	5·3	35·8	35·9
14-	150·9	7·0	[148·3]	146·1	40·1	6·1	[39·4]	39·8

B. Curves of Mental Development

The psychologist is continually asked to predict the probable development of a subnormal child. But unfortunately no very sound basis exists. The employment of the mental ratio for defining general borderlines and forecasting future progress implies that, during the school period at any rate, mental growth, like physical growth, is uniform, and can be represented by a straight line. Certainly, repeated testing shows that with normal children the mental ratio remains pretty constant from 4 to about 12 or 13; on the other hand, with the mentally defective, as is now generally recognized, it begins to decline soon after the age of 10.[1] In considering the dull and backward, therefore, it becomes essential to inquire what precisely is the relation between mental age and chronological age? Is it linear, or is it not? Can it be reduced to any simple law? And where and how large are the errors likely to be, if we adopt the ordinary assumption?

Even with normal children, the law of the constancy of the educational[2] and the mental[3] ratios is only an empirical law, true merely as a first approximation. We need to know whether the implications of such a law are consonant with other forms of human and animal development and learning, and whether a more exact formula can be deduced which will enable us to predict the course of individual development at stages where the application of the mental ratio avowedly breaks down, *e.g.* at puberty and afterwards, and at stages where it has not yet been shown to hold good, *e.g.* the pre-school period. When converting a test-measurement into an equivalent mental age, by means of a list of age-averages, some device for smoothing and interpolation is constantly required. And again in calculating age-allowances for candidates who compete for junior county scholarships and the like a similar problem arises, and becomes acute when (as in many areas) the age of the candidates ranges over two or more years. Were it possible to formulate typical equations for different kinds of mental growth, all such

[1] These conclusions were shown by repeated measurements on small groups recorded in *Mental and Scholastic Tests* (1921, pp. 151 *et seq.*), and have since been confirmed for London children by more extensive data. The practical difficulties caused by an ignorance of the precise relation between mental and chronological age are admirably illustrated by the discussion on borderlines for the retarded and the feebleminded in the *Joint Report on Mental Deficiency* (1929): the upper limit for feeblemindedness was fixed at a mental ratio of 70 per cent. for children from 7 to 14, and at one of 60 per cent. for adults; during the intervening period, from 14 to 16, the borderline mental age was progressively lowered—admittedly only a provisional suggestion (*loc. cit.*, pt. iv, p. 46; cf. pt. ii, pp. 137 *et seq.*). With defectives the *Report* also notes how the constancy of the mental ratio breaks down after the age of 10, when an appreciable decline becomes manifest (pt. iv, p. 100).

[2] *Distribution and Relations of Educational Abilities* (1917), p. 31.

[3] *Mental and Scholastic Tests* (1921), pp. 151 *et seq.*

deductions would be greatly facilitated.

Several types of equation have been suggested in the past. But so far no systematic comparison appears to have been undertaken. The endeavour to obtain provisional norms for this inquiry has led us to collect a large number of physical and mental measurements at different ages which have enabled us to make some provisional study of the various formulæ that have been, or might be, proposed.[1] Many urgent problems could be solved if teachers with a mathematical turn of mind would try out the devices hitherto suggested by applying them to the data which they alone can conveniently collect.

The main types of growth- or learning-curves, with their equations, may be broadly classified as follows :

(1) *Straight-line Equations.*—To a first approximation, throughout the ages with which we are mainly concerned, physical development, as measured by height and weight, obeys fairly simple laws. These may be expressed by saying that increase in height follows an arithmetical progression, and increase in weight a geometrical progression. During the school period, therefore, growth in height may be roughly represented by a linear equation like the following :

(i) for boys,

$$\text{height (in centimetres)} = 75{\cdot}34 + 5{\cdot}1 \times \text{age} \quad . \qquad (1)$$

$$\text{or (in inches) } 29{\cdot}7 + 2 \times \text{age} \quad . \quad . \quad . \quad . \qquad (2)$$

(this means that, to find the normal height in inches of a boy of a given age, we merely double his age and add 30) ;

(ii) for girls,

$$\text{height (in centimetres)} = 72{\cdot}5 + 5{\cdot}4 \times \text{age.} \quad . \qquad (3)$$

The equations for obtaining equivalent chronological age ('physical age' or 'height age') from measurements of height in centimetres or inches can be deduced from the foregoing by simple conversion : *e.g.* for the girls,

$$\text{age} = \frac{1}{5{\cdot}4}\,(\text{height in cm.} - 72{\cdot}5)$$

$$= {\cdot}185\,(\text{height in cm.}) - 13{\cdot}433 \quad . \quad . \quad . \qquad (4)$$

Thus from age 4 to age 12 the curve for height for both sexes is almost a straight line[2]: growth proceeds at the rate of about

[1] I am much indebted to various research-students who have assisted me, not only in collecting data, but also in working out the provisional calculations summarized below. It is hoped to publish a more detailed review later.

[2] Professor Karl Pearson puts the same conclusion even more emphatically: 'From the age of 2 to 18 no better description than a (straight) line could be found' (*On the Graduated Character of Mental Defect*, p. 36). His remark, and the results of his investigations of the curves for height and weight, were published in criticism of my statement that 'except for rough and popular purposes, any measurement of mental capacity in terms of age is unsatisfactory.' There is, however, no great difference between us : my point was simply that, although for 'rough and popular purposes' mental ages must often suffice, nevertheless for scientific research—and ultimately for practical purposes as well—something more exact is needed.

2 inches per annum for the boys and $2\frac{1}{8}$ inches for the girls. So far, therefore, the rule for physical growth is in agreement with the main assumption on which the ordinary concept of mental age is based, namely, that the annual increments are equal. A glance at Fig. 13 (p. 650) shows that this is approximately true, at any rate for normal children, between the ages of 3 and 13.

Further, as will be clear from the table, during the same period the standard deviations for height increase almost in direct proportion with the average height at each age and therefore with age itself. Here we have some incidental justification, or at least an analogy, for the further postulate on which the concept of the mental ratio is based, namely, that, with intelligence, $\frac{\text{standard deviation}}{\text{age}} =$ constant. With weight, it will be noted, the standard deviation, like the age-averages, shows a curvilinear change; but the main feature is still a steady increase of variability with increasing age—at least during the period of growth. However, variability, as we have seen (p. 141), is much more influenced by the approach to limits than is the annual increment. Towards puberty, and, indeed, during the phases of accelerated growth generally, the standard deviation is increased still further; when growth is nearly over, it begins rapidly to diminish.

It may be remarked that equations (1)–(3) are in keeping with the simple law proposed by many biologists,[1] which states that the growth in the length of parts (y) is in linear proportion to the growth of the length of the body as a whole (x), *i.e.* that the growth-equation takes the form

$$y = ax + b \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

It has, however, been frequently urged[2] that this should be regarded merely as a special case of, or a first approximation to, a logarithmic formula of the type

$$y = a' (x + c)^k \qquad . \quad . \quad . \quad . \quad . \quad . \qquad (6)$$

If k is approximately 1, the linear approximation is evidently justified. If not, it is still possible that, by changing the origin so that x is negative, or by changing the scale so that x is fractional, a sufficiently close fit may be obtained by an expansion to terms of the first degree only—*e.g.*

$$y = a' (c^k + kc^{k-1}x) \text{ or } y = a' (1 + k \log x + c).$$

We shall investigate this in the case of weight in a mo-

[1] For human growth, the most interesting deduction of this equation—sometimes cited as Scammon's law—is to be found in Scammon & Calkins, *The Development of the External Dimensions of the Human Body During the Fœtal Period* (Univ. Minnesota Press, 1929).

[2] *E.g.* J. Huxley, *Problems of Relative Growth*, p. 133.

ment. Meanwhile, let us observe that the constancy of the mental ratio is expressed by

$$\frac{y}{x} = a \text{ (a constant) or}$$

$$y = ax$$

where $y \equiv$ mental age, $x \equiv$ chronological age, and a is the mental ratio. This is obviously the general equation (5) reduced to its simplest form.[1]

(2) *Single Curves.*—(*a*) *Convex and Hyperbolic.*—To allow for pubertal retardation and ultimate arrest,[2] a more complicated formula is necessary. The simplest expedient is to add to the above equation a further term which will set an asymptotic limit to the curve. Thus, for girls, taking the limit as a height of 160 cm., the equation becomes

$$\text{age} = \cdot 185 \text{ height} - 13\cdot 43 + \frac{1}{160 - \text{height}} \quad . \quad . \quad (7)$$

The equation represents a hyperbola, and is analogous to the hyperbola often suggested for describing the curve of learning.[3] When converted to derive height from age, the formula becomes

$$\text{height} = 72\cdot 5 + \frac{5\cdot 4}{2}\left\{(\text{age} + 16\cdot 2) - \sqrt{(\text{age} - 16\cdot 2)^2 - \cdot 74}\right\} \quad (8)$$

[1] In the case of the normal child the ratio $a = 1$, and therefore $y = x$. But such a formula, like the preceding formulæ for deducing 'height age,' etc., assumes a single regression equation rather than two, in spite of the fact that the correlation between the two variables is never absolutely perfect. Is this justifiable ? It has often been urged that it is not—that two regression-equations are possible and that the wrong one has been chosen (cf. L. L. Thurstone, 'The Mental Age Concept,' *Psych. Rev.*, XXXIII, 1926, pp. 268–78, and Godfrey Thomson's reply, *ibid.*, XXXV, 1928, pp. 398–413). There seem to be two arguments that justify the current procedure. First of all, if, as is approximately the case except at the extreme ends of the growth period, (i) the distribution with each age is normal, (ii) the standard deviation steadily increases with increasing age, and (iii) the numbers in each age-group are approximately the same, then, as I have elsewhere shown (*Distribution of Abilities*, p. 92, and Table XXXII), 'the correlation cannot be "normal",' and the usual regression formulæ, based on the assumption of a normal correlation surface, do not strictly apply. The two regression lines diverge but slightly. This, indeed, is commonly the case where one of the variables to be correlated is a time-series (cf. Yule, *J. Roy. Stat. Soc.*, LXXXIV, 1921, p. 526, and refs.). Secondly, in deducing a 'mental age' or a 'height age' from a child's measurements with an intelligence test or with a yard measure, we are not seeking to predict the most probable chronological age of that child from a fallible and indirect criterion. We merely define mental age (or height age) as the equivalent, in more convenient units, of the average test-measurement (or the average height-measurement) of all children of a given chronological age, not—be it noted—as the average chronological age of all children obtaining a given test-measurement or possessing a given height.

[2] My figures for height and weight at ages before or after the elementary school period are scarcely reliable enough to deserve inclusion in the table. For these ages I have relied mainly on the results tabulated by Greenwood and Whipple, adjusting them, on the basis of their figures for the school period, so that they may represent a type of population similar to that from which the pupil of the London elementary school is drawn.

[3] *E.g.* Thurstone, 'The Learning Curve Equation,' *Psych. Mon.*, XXVI, 1919, pp. 1–51.

Now, as I have pointed out elsewhere,[1] during the whole educational period (4 to 24 years) the general shape of the curve for height is remarkably similar to that which is obtained from intelligence tests standardized in terms of a mental age. With the Binet scale the approximate formulæ are as follows :

$$\text{(i) age } (x) = y + \frac{1}{15 - y} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

$$\text{(ii) intelligence } (y) = \tfrac{1}{2}\left\{15 + x - \sqrt{(15 - x)^2 + 4}\right\} \qquad (10)$$

It will be noted that formulæ (8) and (10) imply much the same age for the approximate cessation of growth in the case both of height (at any rate among girls) and of intelligence—namely, 16·2 height years and 15 mental years respectively. The Binet tests, of course, measure mental development in terms of mental years, and so implicitly assume a linear equation so far as the mental ages are taken : with group tests the actual results diverge a little more from this theoretical line ; but the divergence is not very great, since, with most group tests for children of school age, the annual increments are roughly equal throughout the period during which their application is justifiable.

(*b*) *Convex and Antilogarithmic.*—A hyperbola certainly furnishes the simplest method of rounding the corner between two straight lines—the upward slanting line for growth during the school period and the horizontal line to which growth becomes asymptotic as it comes to an arrest. But, in the case of height, a somewhat better fit is given, at any rate at the later stages, if the formula is antilogarithmic (*i.e.* exponential) instead of hyperbolic : *e.g.*,

$$\text{height} = 72{\cdot}5 + 5{\cdot}4 \text{ age} - 23{\cdot}6\,(0{\cdot}49)^{\text{age}} \quad . \quad . \quad . \qquad (11)$$

Now, on measuring the annual increment in terms of the standard deviation instead of in terms of itself, I have shown that, during the school period, the development of intelligence can also be expressed by an equation of this type.[2]

As regards the simpler curves of learning, there has been a good deal of controversy among psychologists as to whether a hyperbolic

[1] *The Measurement of Mental Capacities* (Oliver & Boyd, 1927), pp. 26 *et seq.*

[2] *Mental and Scholastic Tests*, p. 244. Expressed with mental years as units, a moderately good fit is given by the somewhat inelegant equation

$$y = \text{age} + 0{\cdot}5 - {\cdot}025e^{0{\cdot}367\,(\text{age} - 4{\cdot}3)}$$

Adopting the more familiar method of logarithmic plotting, we obtain

$$y = 84 \log\left(\frac{\text{age}}{10} + 3\right) - 40{\cdot}5.$$

A simple logarithmic curve of this general type has been a favourite suggestion with many investigators who have used intelligence-tests : (for more recent examples, see Dearborn, *Intelligence Testing*, p. 89 ; Pintner, *Intelligence Testing*, pp. 77–80 ; Gesell, *Infancy and Human Growth*, pp. 340 *et seq.* and figures). Exact equations, however, specifying constants, etc., are rarely given.

or an antilogarithmic formula gives the better fit to the usual curve of learning. These alternative suggestions, however, do not really conflict. By expanding the exponential function in accordance with the theorem of mean value, it is easy to demonstrate that, during the later phases of the curve at any rate, the hyperbola is in effect a first approximation to the exponential curve.

(*c*) *Concave and Antilogarithmic.*—When we turn to weight, an exponential curve almost inevitably suggests itself. In most theoretical investigations on growth, the total body-weight has been generally adopted as affording the most convenient single measurement. Since the bulk, and therefore the weight, of an organism are in the main the result of continued multiplication, we naturally expect that the typical growth-curve that results will be antilogarithmic. Since the rate of increase itself increases, the term containing the exponential function must now be positive, not negative; and the curve will be taken in its direct form, instead of being inverted and reversed.

During the elementary school period, the following equations fit the curves for increasing weight pretty closely:

(i) for boys

$$\text{weight} = 1{\cdot}00 + 9{\cdot}53\ (1{\cdot}1020)^{\text{age}} \quad . \quad . \quad . \quad . \qquad (12)$$

(ii) for girls

$$\text{weight} = 0{\cdot}57 + 10\ (1{\cdot}0988)^{\text{age}} \quad . \quad . \quad . \quad . \qquad (13)$$

These formulæ relate weight to age. But for many purposes it is more important to relate weight to height. As we have already seen,[1] the fact that a child is under the average weight for his age does not of itself necessarily signify that he is under-developed or ill-nourished; a higher correlation with malnutrition is obtained if we compare weight with height rather than with age. We require, therefore, to deduce a further equation connecting the two. By applying Taylor's theorem, the term containing age as an exponent can be expanded in terms of increasing powers of age. Using equation (1), we can substitute height for age; and we thus obtain approximate formulæ of the following type: for boys of school age,

$$\text{weight} = \frac{1}{581}\ (\text{height})^2\ (\text{approx.})$$

$$\text{or} \quad \text{weight} = \frac{1}{91827}\ (\text{height})^3,\ \textit{i.e.}\ 0{\cdot}000011\ (\text{height})^3\ (\text{approx.}) \quad (14)$$

according to the number of terms we include: (on adding a further term, the lower powers approximately cancel out).

Now, the majority of the simple *a priori* formulæ for deducing the

[1] Above, p. 176, footnote 1.

normal weight of a well-nourished child from his actual height have been based on the notion that weight should vary with the cube of height. Height measures growth in one dimension only; but weight depends on bulk, which involves growth in three dimensions. Thus Greenwood seeks to show that, 'at all ordinary school ages, *i.e.* from 8 to 14,' height bears a constant proportion to the cube root of the weight, the proportion being 'practically the same for boys as for girls.'[1] Livi's index of nutrition,[2] well known to school medical officers, is calculated on the same basis by the formula $\frac{100\sqrt[3]{W}}{H}$. During the school period[3] this ratio is usually taken to be $2\frac{1}{4}$. This gives, as an approximate average,

$$\text{weight} = 0{\cdot}000012\ (\text{height})^3 \quad . \quad . \quad . \quad (15)$$

On comparing equations (14) and (15) we see that Livi's index and my own formulæ give results as consistent as could be expected.

Neither, however, yields a very exact determination when we apply them at the separate ages. Nor, indeed, can we expect them to. The growth of most animals is greatest in the antero-posterior direction; and, in keeping with this general law, children grow more in height than they do in other dimensions. Hence a lower power than the cube should give a better fit. With my own data, I find the following relations to hold good during the school period:

(i) for boys

$$\text{weight} = \frac{1}{1716}(\text{height})^{2{\cdot}22} \quad . \quad . \quad . \quad (16)$$

(ii) for girls

$$\text{weight} = \frac{1}{1607}(\text{height})^{2{\cdot}25} \quad . \quad . \quad . \quad (17)$$

Thus weight apparently varies, not as the cube of the height, nor yet as the square, but—as, indeed, one might expect—somewhere between the two, namely, as the $2\frac{1}{4}$ power or thereabouts.[4] The larger exponent for the girls indicates that with them the curve for weight bends upwards more sharply—*i.e.* that the older girls become disproportionately heavy for their height.

The connexion between height and weight, however, varies, not

[1] A. Greenwood, *Health and Physique of School Children*, pp. 11, 20.

[2] See above, p. 176.

[3] Actually it diminishes from about 2·5 at the age of 5 (rather less for girls) to about 2·25 at 14.

[4] Karl Pearson has independently deduced an analogous formula, viz. (converting his figures into metric units):

$$\text{weight} = \frac{1}{2870}(\text{height})^{2\frac{1}{3}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

(*loc. cit.*, p. 37). His calculations were based on the British Association data, for males only. The data were obtained in 1883, and included, it would seem, a slightly excessive representation of the better classes.

only for persons of different age, but also for persons of different physical type, and that quite apart from the influence of malnutrition or ill-health. Such differences have long been commented on by school medical officers and others; and some have even argued that standards of nutrition should only be compared after allowing for the physical type to which each child belongs.[1] A few, it is true, have altogether questioned the existence of such types; and no doubt physical types, in the popular sense of mutually exclusive and contrasting classes, cannot be discovered. But *tendencies* towards this or that extreme may easily be demonstrated by means of correlation. One method, for example, is to take a number of longitudinal measurements and express each as a ratio of the corresponding transverse measurement (*e.g.* total height as compared with shoulder breadth, length of legs as compared with breadth of hips, length of trunk as compared with antero-posterior thoracic diameter, length of sternum as compared with transverse xiphoid diameter, length of face as compared with breadth of face, etc.). The correlations are all positive, and with older children reach an average of nearly ·45. Moreover, the coefficients themselves reveal a hierarchical arrangement, and so suggest a general factor. According as this factor is high or low, two physical 'types' may be distinguished—namely, those tending to be tall, slender, and light, and those tending to be short, thick-set, and heavy. A regression equation can easily be deduced by which one can estimate the tendency of any particular individual to this type or to that. By partial correlation it is possible to eliminate the influence of general malnutrition, and to show that the physical type is often in the main a constitutional characteristic. Such calculations and such speculations, however, are rather of a theoretical than of a practical interest.[2]

[1] Coerper, *Zeitschr. f. Kinderheilkunde*, 1920, p. 30. One writer has even proposed to take the simple ratio of height to weight as an 'index' of 'morphologic type' (Naccarati, *Arch. Psych.*, XLV, 1921, p. 8).

[2] I have discussed the existence of these physical types in greater detail in my paper on 'The Mental Differences between Individuals' (*British Association Annual Report*, 1923). The earliest attempt to measure such characteristics systematically appears to have been that of De Giovanni and his pupils, *Morfologia del corpo umano* (Milan, 1891); a physical classification of children was developed on this basis by F. Frassetto (U.S.A. Department of Labour, *Bulletin* No. 60, 1919, 'Standard of Child Welfare'). Similar classifications have more recently been popularized by Kretschmer; and the two types named by him the 'pyknic' and the 'asthenic' respectively. The work on the influence of endocrine secretion and hormones on growth, bodily characteristics, and emotional peculiarities, has further strengthened the traditional notion of a connexion between physical appearance and temperamental type. So far as statistical evidence goes, the correlations between physical types and temperamental qualities are small but positive, and (like the physical type itself) more easily demonstrated in adults than in children. With a group of 73 children, I found a correlation between a tendency towards what I have called the longitudinal physical type and the inhibited or 'introverted' temperamental type to the extent of ·27; among 50 post-graduate students, one of ·38. General emotionality, on the other hand, is higher in the longitudinal type, the correlation being ·25

(3) *Double or S-shaped Curves.*—(*a*) *Symmetrical Logistic Curve.*—The increase of weight, at a speed which itself increases, cannot go on indefinitely; otherwise the weight of a man of 50 would be over 44 stone. As with height, so with weight, towards the end of childhood growth is gradually arrested. We need, therefore, an addition to our exponential formula, to round off the curve for weight at the upper end as we rounded off the curve for height. Similarly, at the lower end, the curves of height and intelligence should presumably begin with a concavemovement upward, as does the curve for weight. To assume that growth in height and intelligence starts suddenly at birth with maximum speed seems scarcely plausible: certainly, during the first three or four months after conception, the rate of increase in length of body is itself greatly accelerated. And the same holds good of curves of learning: when accurate measurements are procurable for the earliest stages of all, there is a positive acceleration at the outset and a negative acceleration at the close.

We may express this analytically by saying that the rate of increase, $\frac{dy}{dt}$, is more or less proportional (i) to the amount of growth already achieved and (ii) to the amount of growth that remains to be achieved, or, in other words, (i) to the distance the child has travelled from zero growth and (ii) to the distance he has yet to travel to reach maximum growth, *i.e.* maturity. The nearer he is to either limit, the slower he grows: his rate of growth is fastest midway between the two limits; it is zero (i) when there is nothing to grow and (ii) when perfection has been attained. If, therefore, we cannot say more precisely what relation his rate bears to these two varying amounts, it will be best to take the simplest function that fulfils the conditions specified. Accordingly, assuming provisionally that the combined proportions are constant ($= \frac{1}{a}$ say), we may write

$$\frac{dy}{dt} = \frac{1}{a} \cdot y \cdot (1 - y) \quad . \quad . \quad . \quad . \quad (19)$$

where y is the amount of growth already achieved at time t, and the maximum growth to be attained at maturity is put equal to unity.

To obtain and plot the curve of growth, it will be convenient to alter the origin and units, so that $a = 1$, and both time (t') and growth (y') are measured from the midpoint or average. Then zero

(owing possibly in my own cases to the presence of several children with hyperthyroid and hypothyroid tendencies). Since in most animals growth proceeds in an antero-posterior direction—in the child, for example, the head grows earlier than the legs—it is tempting to regard the 'pyknic' type as conforming to a more primitive pattern. Naccarati finds a correlation of ·23 between microsplanchnic (longitudinal) physique and intelligence: in my own data the correlation is too small to be significant.

growth will be -1, and maximum growth $+1$, so that $y' = 2y - 1$. We may accordingly re-write the differential equation

$$\frac{dy'}{dt'} = (1 + y')(1 - y') \quad . \quad . \quad . \quad (20)$$

The changing rate of growth will thus be represented by a symmetrical wave, a curve of limited range (Pearson's Type II) not unlike the symmetrical probability curve of unlimited range (the normal curve obtained from the binomial). The solution of (20) is

$$y' = \tanh t'$$

and the values of y' can be found at once from a table of hyperbolic tangents.[1]

Since $\quad y' = \tanh t' = \dfrac{e^{t'} - e^{-t'}}{e^{t'} + e^{-t'}} = \dfrac{1 - e^{-2t'}}{1 + e^{-2t'}}$ we may write

$$y = \frac{1}{1 + e^{-x}} \quad . \quad . \quad . \quad (21)$$

where $x = 2t'$, and y now $= y' + 1$ and denotes the proportion of the total amount of growth achieved at time x. (21) gives the simplest and most fundamental form that can be taken by an equation fulfilling the conditions required.

The curve thus obtained is a symmetrical S-shaped curve, with its point of inflection midway between its two horizontal asymptotes. When y is small as compared with its ultimate value (which we have put equal to 1), the differential equation (19) approximates to $\dfrac{dy}{dt} = \dfrac{1}{a} \cdot y$, the solution of which yields a logarithmic curve $y = A\,e^{t/a}$. During the initial stages, therefore, growth is approximately logarithmic.[2] A similar result can be obtained for the final stages, the later half of the curve being identical with the earlier half inverted and reversed. Thus the whole curve is, as it were, a double logarithmic curve, supplementing the 'compound interest law' $\left(\dfrac{dy}{dt} \propto y\right)$ by the 'law of diminishing returns' $\left(\dfrac{dy}{dt} \propto 1 - y\right)$.

An equation and a curve of this type—known as a 'logistic' or 'Malthusian' curve—have been freely used to describe the growth both of populations and of organisms.[3] If adopted (in the generalized form explained below) to describe the results of mental development

[1] Fisher's table for determining z from r (*Statistical Methods for Research Workers*, Table VB) is such a table, since $r = \tanh z$.

[2] This formula has, in fact, been suggested as providing a better approximation to curves of learning than the hyperbola originally suggested by Thurstone: cf. more especially, H. J. Ettlinger, 'A Curve of Growth Designed to Represent the Learning Process,' *Journ. Exp. Psych.*, IV, 1926, pp. 409–14.

[3] The curve was first suggested by P. F. Verhulst (' Recherches mathématiques sur

and of learning, it brings these phenomena into line with many other dynamic processes, and explains why the various formulæ hitherto proposed, although at first sight so different, nevertheless yield a reasonable fit. From the equation to this curve or from its differential equation, we may, in fact, derive most of the formulæ for curves of growth or learning hitherto advanced on rational or empirical grounds.

We may, for example, generalize the differential equation (20) by writing it

$$\frac{dy'}{dt'} = y_1\left(1 + \frac{y'}{\alpha}\right)^{\nu\alpha}\left(1 - \frac{y'}{\beta}\right)^{\nu\beta} \quad . \quad . \quad (22)$$

and we at once obtain Pearson's general equation for a skew curve of limited range (Type I). Putting $\alpha = \beta$, we obtain Thurstone's equation for the learning curve.[1]

Or again writing (19) in the form

$$\frac{dy}{dx} = e^{-x}(1 + e^{-x})^{-2} \quad . \quad . \quad . \quad (23)$$

we have a symmetrical curve which runs very close to the normal frequency-curve given by $\frac{dy}{dx} = \frac{1}{2}e^{-\frac{1}{2}x^2}$, and a formula which merges easily into that of the skew binomial (type III).

la loi d'accroissement de la population,' *Corr. Math. et Phys.*, publ. par A. Quetelet: Tome X, 1838, pp. 113–21). Quetelet had complained that neither Malthus nor the economists who succeeded him had offered a working formula to express the growth of populations. In response, Verhulst, professor of mathematics at the École Militaire, deduced the equation given above. Since $x = \log \frac{y}{1 - y}$, a proportional or 'logistic' logarithm (as it was termed by earlier mathematical writers), the curve was named by Verhulst the 'logistic curve': its relation to the hyperbolic tangent has not, I think, been explicitly noted. His three memoirs, though now described as 'classics on their subject,' have remained almost wholly ignored until recently. The formula (21) first reappears in inorganic chemistry, where it is used to describe the progress of autocatalytic (self-accelerating) reactions towards a state of ultimate equilibrium (cf. Ostwald, *Vorlesungen über Naturphilosophie*, 1902, p. 342 and refs.). T. B. Robertson adopts it to express the 'autocatalytic' nature of organic growth (*The Chemical Basis of Growth and Senescence*, 1923, cf. esp. p. 17 for growth in human weight). Raymond Pearl seems independently to have deduced it to express the growth of populations (*Studies in Human Biology*, 1924, pp. 558 *et seq.*; cf. also G. Udney Yule, 'The Growth of Population and the Factors that Control It,' *Journ. Roy. Stat. Soc.*, LXXXVIII, 1925, pp. 1–58). The common underlying assumption is that the amount of growth is determined (i) by the (increasing) number of cells or individuals present and therefore able to multiply, and (ii) by the (decreasing) power of assimilation, or amount of material available for assimilation, which is gradually exhausted as a state of final equilibrium is reached.

If, with x and y measured as stated above, we plot the proportional increases $(y_{x+h} - y_x)/y_x$ against the values of y_{x+h} (the values of the ordinates at the ends of the corresponding intervals of time) taken as abscissæ, then the resulting points will lie on a line having a slope of $(e^h - 1)$ and passing through the point $y_{x+h} = 1$ on the x-axis. This yields a rough but convenient method of fitting; more accurate methods are described by Yule and Pearl (*loc. cit. sup.*). With the more elaborate formula suggested below, my method has been to determine $a_1x + a_2x^2 + a_3x^3 + \ldots$ from the given values for y and then to fit a cubic parabola to the figures so obtained.

[1] 'The Learning Function,' *Journ. Gen. Psych.*, III, 1930, pp. 468–94. He assumes

On expanding the equation to the curve itself we are able to understand its relation both to the straight line and to other empirical curves that have been suggested. Viewed in this way these numerous suggestions appear, not as rival proposals (as their advocates seem to assume), but as similar and convenient alternatives for describing a group of curves having definite characteristics in common. We have

$$t' = \tanh^{-1} y' = y' + \frac{1}{3} y'^3 + \frac{1}{5} y'^5 + \dots \quad (24)$$

$$y' = \tanh t' = t' - \frac{1}{3} t'^3 + \frac{2t'^5}{15} - \dots \quad (25)$$

The first series (24) shows clearly that, between $y = -\cdot 7$ and $y = +\cdot 7$, the curve is approximately a straight line. Moreover, being a sum of the odd powers of variables of limited range, with diminishing coefficients, it can evidently be replaced by $t' = \tan y'$ as a first approximation. The second series, being a sum of odd powers with alternating signs, suggests as possible approximations not only (i) $y' = \tan^{-1} t'$, but also (ii) $y' = \int_0^{t'} e^{-t'^2} dt'$ and (iii) $y' = \sin t'$.

The expansion of the probability integral (ii)[1] is very similar to that for tanh t'—a similarity which has already led to the former being treated as equivalent to the latter for other statistical purposes; and the fact that the measurement of growth or learning as a cumulative process takes a form closely akin to the cumulative curve deduced for processes governed by 'chance' (*i.e.* by a large number of small influences) is itself highly suggestive. The arc

that the increasing achievement, which results from experience, consists in an increase in the number of component acts which are successful and a decrease in the number which lead to failure, together with a tendency to repeat past successes and avoid past failures in the future. He conceives this under the analogy of a non-independent ball-drawing problem. Numerous attempts have been made, from Karl Pearson onwards, to express curves of growth and learning by abstract models based on this analogy. One interesting result has been the construction of concrete models, *e.g.* electronic machines, which actually display such phenomena as learning, formerly supposed to be peculiar to the living organism (for the general principles involved, see W. R. Ashby, *An Introduction to Cybernetics*, 1956, and rep.). The most general form for the learning equation based on ball drawing seems to be that derived by Audley and Jonckheere ('Stochastic Processes and Learning Behaviour,' *Brit. J. Stat. Psychol.*, IX, pp. 87–94). As they point out, their formula is a generalization, on theoretical grounds, of one I had myself derived from practical data, obtained during experiments on learning among children and animals: cf. C. Burt and E. Foley, 'The Statistical Analysis of the Learning Process,' *Brit. J. Stat. Psychol.*, IX, pp. 49–62. In these experiments we found that the cumulative effects of learning or growth could be expressed mathematically by repeated multiplication by a factor matrix consisting of 'transitional probabilities': the results obtained gave a close fit to the data: for a non-technical account see 'The Psychology of Learning,' *Educational Review*, February 1958.

[1] The familiar ogive has been suggested by Lehfeldt as suitable for describing the growth of populations (*Journ. Roy. Stat. Soc.*, 1916, p. 329). Its drawback is the difficulty of adapting it to yield asymmetric forms (see p. 649).

tangent formula (i) [1] has already been proposed for curves of learning. The half sine-curve (iii) gives almost as close a fit both to the probability curve and to the logistic. It does not become asymptotic; but that is not necessarily a disadvantage, since curves of growth and learning often show minor fluctuations even after what is ordinarily considered the limit of achievement has been reached.

Once more, if we take only one half of the logistic curve, it is quite easy to find a hyperbola which will fit the lower or the upper limb. Take first the lower limb where x has negative values, and expand e^x to terms of the second degree; we obtain at once

$$y = \frac{1}{2 - x + x^2}$$

The upper limb is similar, but inverted and reversed. By the remainder theorem the amount of error can be calculated; and, for most curves of learning, is less than the experimental error. For curves of growth the approximation is demonstrably inexact. A better fit can be obtained either by working from the differential coefficient or by considering the angle between the two asymptotes and referring the equation of the curve to the latter, taking in either case an equation of the second degree. Either method gives, as a first approximation for the upper limb,

$$x = 2\,(2y - 1) + \frac{1}{20\,(1 - y)}$$

In my view the hyperbola yields a less satisfactory formula, not because it is inexact or based on no rational grounds (the usual point of criticism), but because it gives an unintelligible or arbitrary result at the commencement of the curve. All curves of growth and learning imply in theory a phase of positive acceleration at the beginning and of negative acceleration at the end. In practice, more often than not, the figures actually obtained obscure one or other of these phases; but a theoretical formula which omits one of them altogether is of very limited value. The logistic curve includes both. Its drawback, in the shape so far considered, lies in the fact that, by its symmetry, both phases are inevitably made equal. We have therefore to inquire whether it can be generalized or extended so as to admit of asymmetrical forms.

(*b*) *Asymmetrical Logistic Curve.*—The foregoing results suggest that curves of growth and learning may be conceived on the analogy of the frequency-curves expressing the cumulative results of drawing balls by chance from a box—*i.e.* of hitting by chance upon favour-

[1] Meyer, M. F., and Eppright, F. O., *Am. J. Psych.*, XXXIV, 1923, pp. 203–22; W. L. Valentine, *Journ. Gen. Psych.*, III, 1930, p. 337.

able or unfavourable material for assimilation under special limiting conditions. The symmetrical normal or binomial curve, described by the probability integral as given above, assumes that the increments are independent. This is scarcely plausible: for each further increment of growth is superposed on the last; and each further success in learning may, during the early stages, facilitate the next, or, during the later, leave only the harder points to be mastered. The differential equation (22), however, though involving symmetry as it stands, is, as we have seen, in form analogous to the equation of a type III curve—the asymmetrical binomial curve representing the probability of non-independent events. A slight modification, therefore, would lead to a cumulative curve, like that resulting from the hypergeometric series referred to below (pp. 664 *et seq.*). This, if only it could be integrated with ease, would admirably describe, on a rational basis, most simple curves of learning.

One obvious device for dealing with an asymmetrical curve is to take logarithms of time, and so compress the base-line for chronological age increasingly as age advances. The effect is to reduce the asymmetrical ogive obtained from the actual observations to a form more nearly symmetrical. This is a common and convenient way of using the constants and ordinates of a normal curve (which have been fully tabulated) to describe those of a skew distribution (which have not); but, as applied to the present problem, it yields neither a very practical procedure nor a very good fit.

We may, however, easily generalize the logistic formula given above as follows. In the differential equation (19) the constant $\frac{1}{a}$ may itself change with the lapse of time. This will lead to a more complex function, $F(x)$ say, which must be substituted for the simple exponent x in equation (21); $\log x$ is but one among many such conceivable functions. But $F(x)$ may always be represented to a sufficient degree of approximation by the first three or four terms of a Taylor series. And this, to my mind, forms by far the best way of dealing with the asymmetrical curves of growth and learning.

Thus, a very good fit[1] to the pooled results of intelligence tests for normal children is obtained by putting

$$y = \frac{14{\cdot}8}{1 + e^{-{\cdot}267x + {\cdot}0025x^2 - {\cdot}0024x^3}} \quad . \quad . \quad (26)$$

[1] With these coefficients the curve shows a very slight tendency to increased acceleration towards the ages of 6 and 7, and again at about 11 (cf. Table IX, *Mental and Scholastic Tests*, p. 145). The increase is not quite so marked as it is in the observed results: and both are scarcely discernible in the figure owing to the small scale on which it has been reproduced.

where $y =$ mental age and $x =$ chronological age $- 7{\cdot}4$. For the dull and backward the equation is:

$$y = \frac{11{\cdot}8}{1 + e^{-{\cdot}310x + {\cdot}005x^2 - {\cdot}003x^3}} \quad . \quad . \quad . \qquad (27)$$

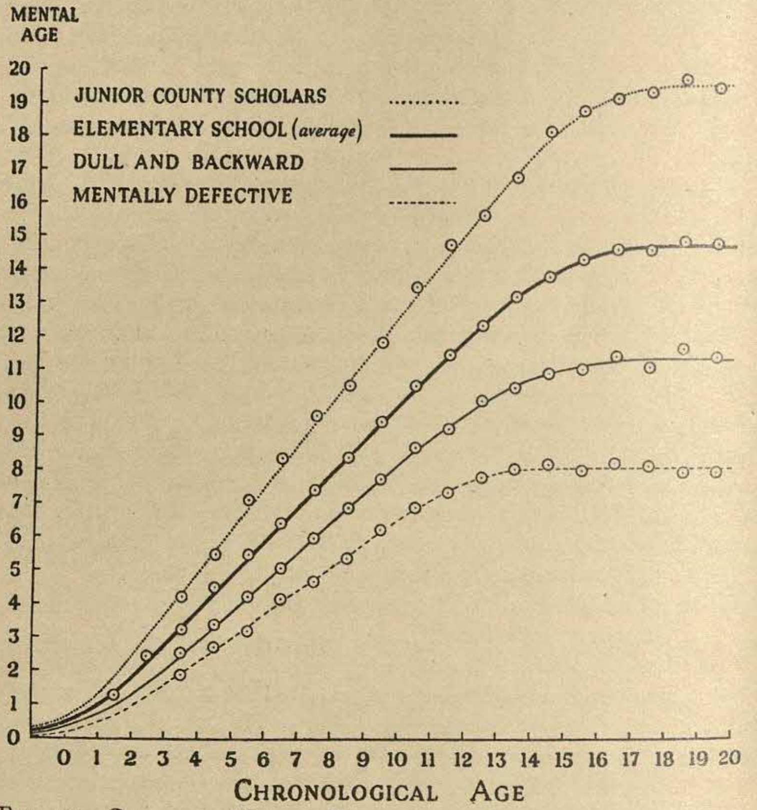


FIG. 13.—CURVES OF MENTAL GROWTH FOR NORMAL, SUBNORMAL, AND SUPERNORMAL CHILDREN

NOTE TO FIGURE.—*The centres of the small circles represent the averages in mental years obtained at each chronological age with tests of intelligence.*

The curves are 'generalized logistic curves,' drawn according to formulæ (26) *to* (29).[1]

[1] Several diagrams of this sort, giving 'theoretical mental-growth curves' for normal and subnormal children, are to be found in recent works on the results of intelligence-testing. As a rule, they appear to be either simple logarithmic curves with no exact constants specified (*e.g.*, Dearborn, *loc. cit. sup.*, Fig. 28, p. 89), or straight lines drawn to fit a constant mental ratio and arbitrarily rounded off at adolescence (*e.g.*, *id.*, Fig. 29, p. 90; Terman, *Intelligence of School Children*, Fig. 20, p. 152). Cf. also Baldwin and Stecher, 'Mental Growth Curve of Normal and Superior Children,' *Univ. Iowa Studies*, II, 1, 1922.

where x = chronological age — 7·1. Between the ages of 5 and 14 a moderately good fit is given by taking $y = \frac{11\cdot8}{15\cdot0}$ normal age = ·785 normal age, *i.e.* by assuming that the dull child's mental ratio is constant at about 79 per cent. Actually, however, the mental ratio of the dull as determined from the logistic equation shows a slight increase from 7 to about 12, and a slight diminution after that age. This is in agreement with the detailed test-results. It follows that, when based on the customary assumption of a constant mental ratio, the prognosis given for the dull and backward youngster at the age of 4 will probably be too gloomy, and the prognosis given at the age of 10 too optimistic.

The theoretical curves, deduced from these equations, together with the actual averages[1] at each age, are shown in Fig. 13. For comparison I give curves for mentally defective children attending special schools and for junior county scholarship winners. The equations are—for the mentally defective

$$y = \frac{8\cdot2}{1 + e^{-\cdot322x + \cdot007x^2 - \cdot0006x^3}} \quad . \quad . \quad (28)$$

where x = age — 6·4; for the scholarship children

$$y = \frac{19\cdot7}{1 + e^{-\cdot23x + \cdot004x^2 - \cdot003x^3}} \quad . \quad . \quad (29)$$

where x = age — 7·7.

(*c*) *The Log-log Curve.*—The fact that the left limb of the curve thus deduced is infinite and becomes asymptotic, as well as the right limb, presumably indicates that growth cannot occur unless something already exists to grow. Nevertheless, the start of growth is comparatively sudden, and the organism as such does not exist before conception. Hence the initial phase of positive acceleration

[1] In obtaining figures for the dull and backward it is, of course, misleading to compare average test-results for different children at each successive year. Since at each year the backward are defined as those having mental ratios between 85 and 70, this definition would of itself virtually determine the average mental age for each chronological age. Hence I have limited myself only to those children whom I have tested and re-tested at succeeding years. For the mentally defective I have used both methods: the selection is made in most cases mainly at much the same stage of life; hence the fallacy does not arise. For the scholarship children my results for ages before 11 are based on test-measurements obtained from young children who happened later to win scholarships: the cases are few; and the results at these earlier years are therefore not very reliable. The same holds of the averages for ages after 14 for all groups except the scholarship winners. The mental ages at the higher levels are purely conventional. The method followed has been to convert the marks obtained by each child in the intelligence tests into terms of the standard deviation of each age-group. It has then been assumed that the relation between the standard deviation and the mental ratio is constant, namely, S.D. = 13·5 M.R. for most tests; and from this the child's mental age can be deduced. It is possible that the mental ages thus assigned for scholarship children of 14 and upwards are a little too high. Some investigators would prefer a wider standard deviation. Moreover, since the poorer scholarship winners tend to leave earlier, the older age-groups probably include a slightly better selection.

is almost invariably shorter and sharper than the terminal phase of negative acceleration. This is indicated by the fact that the coefficients of x, x^2, x^3, . . . diminish rather rapidly.[1] Thus, in many curves of growth, they are roughly of the order and proportions of $-\frac{1}{10}$, $+\frac{1}{200}$, $-\frac{1}{3000}$, so that $F(x)$ approximates to $-\log_e\left(\frac{x}{10}+1\right)$. This would suggest taking the logarithm of the time, as described above, and would yield a curve in which the later phase of positive acceleration is about twice as long as the earlier phase of negative acceleration.

Alternatively, starting with the usual growth equation $y = e^z$, we may round off the upper end of the curve by taking $z = -e^{-t}$, *i.e.* instead of taking logarithms of the abscissa (time) we take antilogarithms of the abscissa and logarithms of the ordinates. An equation of this type was proposed[2] about a century ago by the Jewish actuary, Benjamin Gompertz (a Fellow of the Royal Society), to describe the curve of mortality for the use of life insurance companies. It has recently been adopted by Courtis[3] to express the 'general form of biologic growth.' His formula is $y = y_1 i^{r^t}$, where y (as before) is the amount of development attained at time t, y_1 the maximum attained at maturity, i the point at which growth begins, r the rate of growth, and t age or time measured on a special isochronic scale. An equation of this character, he finds, gives an extremely close fit to the frequencies[4] I obtained with the Binet-Simon tests of intelligence as applied to London children. It also fits, so he alleges, growth in height and weight (at any rate within the years for which his data were available), ossification of

[1] This is partly obscured in the equations just given owing to the fact that many of the test-results are based on scales that assume a simple linear relation between age and increase of intelligence.

[2] B. Gompertz, 'On the Nature of the Function Expressive of the Law of Human Mortality,' *Phil. Trans. Roy. Soc.*, 1825, pp. 513 *et seq.* A life table calculated by Gompertz's formula agrees with the best of the tables compiled by empirical methods as closely as the empirical tables agree with each other: in actual practice the tables commonly used are those derived from a slightly more complex version of the same formula, devised by Makeham (*Journ. Inst. Actuaries*, 1860).

[3] S. A. Courtis, *The Measurement of Growth* (Michigan: Brumfield & Brumfield, 1932). The suggestion was apparently due in the first instance to Professor H. C. Carver. A convenient summary will be found in *Brit. J. Psych.*, XXV, 1934, pp. 106–13.

[4] *Loc. cit.*, p. 59, and Appendix, pp. 21–6. Although the formula fits the frequencies, it does *not* provide a good fit to the average mental age obtained at each successive year; however closely the constants are adjusted, the results are, at most ages, at least half a year out. Courtis, nevertheless, claims that his equation fits the averages obtained by C. A. Richardson with group tests of intelligence applied to school children in Blackburn; and Richardson himself has worked out a detailed comparison on the same lines (Stokes and Richardson, 'Growth and Variability of Intelligence,' *Brit. J. Mon. Sup.*, VI, 18); but there the age-range was comparatively narrow. I myself find that the logistic formula given above fits both Richardson's data and my own much better than any equation of the Gompertz type.

carpal bones, eruption of teeth, most of the curves of learning to which he has applied it, and the growth of plants, animals, and populations.

The formula is equivalent to putting — log y as an approximation for $(1 - y)$ in the differential equation (19). And the relation of the curve to the asymmetrical logistic may be exhibited by measuring time, as before, from the point of inflection. We then have $y = k\, e^{-e^{-x}}$

$$= \frac{k}{1 + e^{-x} + \frac{(e^{-x})^2}{2!} + \frac{(e^{-x})^3}{3!} + \cdots}$$

where, so long as x is small, all terms in the denominator except the first two become negligible. For mental age and chronological age, the formula gives $y = 14{\cdot}8e^{-e^{-\frac{\text{age} - 5\cdot2}{4\cdot93}}}$, not a very satisfactory fit. As the constants here indicate, the point of inflection (the age at which half the mature attainment is reached) is inevitably fixed at the time when approximately one-third of the total period of maturation has expired: the curve is therefore asymmetrical in approximately those proportions. The defect of the curve lies in its rigidity: why should every developing process always attain one-half of its final value when one-third of the total period of development has elapsed? Nor are the verifications so convincing as they sound. As Courtis points out, it is difficult to obtain data sufficiently extensive for a comparison to be made over the whole course of the curve. My own experience suggests that the phase of retardation bulks too large, and follows the phase of acceleration too suddenly, for the formula to show the intermediate phase of steady progress that characterizes most curves of growth and learning.

(4) *Fluctuating Curves.*—So far we have assumed that curves of growth and learning are smooth. Indeed, the main object of such equations is to find a simple formula for determining the general trend. Actually, however, most curves based on empirical averages show marked irregularities. When the process tested is at all complex, they display minor phases of acceleration and retardation, more or less rhythmical, in addition to those shown at the beginning and the close, superimposed upon the main trend and producing what are sometimes termed plateaux. Often it is desirable not to smooth away, but to study, these lesser fluctuations. There are two main ways in which we may seek to incorporate them into our final equation.

(*a*) *Superposed Curves.*—If we plot the annual increments in height or weight year by year, we obtain, not a single wave-like

curve, but a succession of waves. When the increments in height are expressed as proportions of the total height at the beginning of each year, we may discern at least three diminishing waves, not unlike the damped periodic waves described by an exponential-sine equation. To determine and then solve a differential equation in this form would be neither a very straightforward nor a very instructive task. It is simpler to treat the total result as the effect of separate waves superposed.

Adopting this principle and taking the figures for the height of London girls, I obtain an equation of the following type:

$$h = \frac{100}{1 + e^{-1\cdot60x_1 + 0\cdot885x_1^2 - 0\cdot175x_1^3}} + \frac{5}{1 + e^{-1\cdot15x_2}} + \frac{55}{1 + e^{-0\cdot415x_3 - 0\cdot0034x_3^2 - 0\cdot0029x_3^3}}$$

where h = height in centimetres, and x_1 = age, x_2 = age − 7·9, x_3 = age − 11·1. Here growth in height is analysed into three main cycles: first, a period of very rapid growth reaching its maximum rate just before birth, diminishing after birth, and ultimately carrying the child to a height of approximately 100 cm.; secondly, a minor phase reaching its maximum rate at about 7 or 8, *i.e.* about the time of the second dentition, and ultimately carrying the child to a height of (100 + 5) cm.; thirdly, a phase beginning about the commencement of the school period, reaching its maximum at about 11 or 12, fading out towards 18, and ultimately carrying the child to a height of (100 + 5 + 55) cm. = 160 cm. at maturity.[1] The curve for weight has a different form from that of height. For girls a moderately good fit is given by

$$w = \frac{9}{1 + e^{-3\cdot3x_1}} + \frac{14}{1 + e^{-0\cdot35x_2}} + \frac{32\cdot5}{1 + e^{-0\cdot40x_3}}$$

where w = weight in kilograms, x_1 = age − 0·2, x_2 = age − 4·5, and x_3 = age − 14·5.

At first sight a comparison of the two equations might seem to lend support to the view, popularized by Stratz,[2] that growth con-

[1] The majority of London children are ill-nourished. This appears to shift the times of maximum acceleration. The maximum for the second phase, like dentition itself, is somewhat postponed. On the other hand, the pubertal phase is arrested a little earlier; and this has the effect of slightly antedating the point of maximum acceleration during this third phase.

[2] C. K. Stratz, *Der Korper des Kindes und seine Pflege* (Stuttgart, 1909). His diagram is reprinted in the Report of the Consultative Committee of the Board of Education on *The Primary School* (1931, p. 225; cf. also pp. 24 *et seq.*). The diagram itself, however, shows that the theory of a simple alternation cannot be applied in the same way to both sexes; and moreover the variations are by no means so large

sists in periods of 'stretching out' alternating with periods of 'filling up.' Similar alternations have been observed in the growth of many animals.[1] But in the human being the variations between 3 and 14 are much slighter than is popularly supposed: there is nothing like the *crises de croissances*[2] in which earlier psychologists believed. Moreover, alternation is scarcely a correct description of the relation between the two processes. With girls the first rapid increase in weight coincides almost exactly with the first rapid increase in height, and its maximum rate occurs almost immediately after the maximum rate for height. The second acceleration in weight is really composite; and the date of the second maximum, as given by the equation, is the result of smoothing. During the school period, the detailed graph for variations in rate shows, not one maximum at 4·5, but a series of maxima at 3·5, 8·3, and 11·3 years or thereabouts. A closer scrutiny of a similar graph for height reveals minor increases in rate at very much the same ages, though naturally in height the increases are not so well marked, since changes of rate are bound to be less obvious in a measurement that depends on one dimension only. In the curves for height and weight obtained for boys the parallel between the fluctuations is still closer. The third maximum for weight admittedly falls much later than that for height; but is definitely related to the changes of puberty.

It appears then that, during childhood, the successive maxima in the rate of increase in weight are an almost immediate consequence of the corresponding changes in height; and after the first rapid rise none of them is very large. My conclusion accordingly is that physical growth, as measured alike by height and by weight, is analysable into two conspicuous cycles only—the first, an infantile cycle, ranging from conception to age 3 or 4 with a maximum about the time of birth, and the second a pubertal cycle with a maximum for height and weight different from each other and different in the two sexes. During the school period itself, there are certainly

as the diagram suggests. Stratz's chart is also reprinted in Kerr's volume on *The Fundamentals of School Health* (p. 42), and the numerous criticisms of Stratz's views are there briefly summarized. The most thorough mathematical analysis of the problem is that made by J. Berkson, 'Growth Changes in Physical Correlation: Height, Weight, and Chest-circumference of Males,' *Human Biology*, I, 1929, pp. 462–502.

[1] For examples, see Huxley, *loc. cit.*, p. 203. Since the amount and spacing of these maxima seem to alter progressively, it becomes tempting to speculate on the analogies that may exist with the logarithmic fluctuations demonstrated by Dr. Philpott and others in curves of mental work and learning (' Fluctuations in Human Output,' *Brit. J. Psych. Mon. Sup.*, No. 17, 1932; cf. also Blackburn, 'The Acquisition of Skill: An Analysis of Learning Curves,' *Reports of the Industrial Health Research Board*, No. 73, 1936).

[2] Claparède, *Psychologie de l'enfant*, 1916, pp. 420 *et seq.*

minor fluctuations: but the outstanding feature is the continuity and steadiness of the rise—nearly linear for height, which is one-dimensional, somewhat concave for weight, which depends on tri-dimensional growth. In lowlier animals the same two cycles are discernible, and can be described by equations of an analogous form. What seems peculiarly characteristic of human development is the remarkable lengthening of the stage that ends with adolescence, resulting in a prolonged period of more or less uniform growth intervening between the climax of the infantile and pubertal cycles respectively.

Now a study of the available data strongly suggests that the same holds good of mental growth. Here, too, there seem to be two main phases. During the pre-school period, and particularly during the first year of life, there is a good deal of evidence to show that, both quantitatively and qualitatively, the child's mind develops at a more rapid pace than at any subsequent time—a pace which is not continuously maintained. About the third or fourth year of life a process of more steady, if slower, advance sets in, which lasts until puberty, when, as has been amply demonstrated by all who have applied tests of intelligence, there is a marked and speedy retardation. Thus, at the two extremes, during the pre-school period and again at puberty and afterwards, the assumption of a constancy in the mental ratio may lead us widely astray.

The two phases of growth are not altogether comparable. In mental development as in physical, the first phase of growth is generally a phase during which the characteristic pattern of the species is laid down: the changes are so complex that a mere quantitative statement can hardly cover them. The second phase is more simple, and consists mainly in a general expansion, true more or less throughout the period to the pattern that has already been determined. It is perhaps in regard to the initial phase of mental and physical growth that we are most in the dark. For height, and in my view for intelligence also, the straight-line formula here breaks down completely. Data collected at nursery schools and elsewhere should throw much light on these unsolved questions, and incidentally may perhaps revolutionize our notion of the general nature of the child's development.

(*b*) *Parabolic Curves.*—It has now, I think, become evident that every equation that might be put forward can claim nothing more than a descriptive value. The notion, held by many earlier writers, that one could, by mathematical analysis, formulate a 'law' of growth or development is, to my mind, mistaken. This conclusion, however, may lead the reader to inquire whether, since the final

logistic equations are so numerous and so complex, a direct empirical fit would not yield a simpler procedure.

Nearly all the equations suggested by different writers for describing curves of growth and learning turn out, as we have already seen, to be closely similar when expanded in a power series. They suggest an equation of the form

$$y = k\ (x \pm b_1x^2 + a_1x^3 \pm b_2x^4 + a_2x^5 \pm \ldots)$$

where $1 > a_1 > a_2 > \ldots > b_1 > b_2 \ldots$ Evidently, therefore, an expression for most of the curves could be reached by fitting a parabola [1] of higher order, with rapidly diminishing coefficients. When this is actually attempted, however, the labour proves even greater than that entailed by the method above described. The result is merely to smooth the curve; and it is doubtful whether the norms that result from such smoothing have any merits which the original age-averages do not already possess. At the same time, the constants that emerge from the process throw no additional light on the characteristics of the curve itself, whereas these are clearly brought out by the logistic formulæ.

Obviously there is much room for further research. The discussions on curves of growth in the Consultative Committee's reports, the curves drawn by theoretical psychologists to illustrate the results of their tests, the attempts made by practical psychologists to predict development and final limits for individual children, the endeavours to find a mathematical expression for the analogous curves of learning, and to express the growth of animals in terms of an algebraic formula—all show that the problem deserves more serious study. Possessing as they do unique opportunities for collecting measurements of growth and intellectual progress, teachers and school medical officers, it is to be hoped, will in the near future turn their attention to such investigations. I would add that the mere analysis of averages is not sufficient, although at present we have scarcely any other material at our command. Systematic observations on a few individuals over a long period of years, particularly of individuals who are subnormal or atypical, would probably correct many rash deductions based on the supposed course of development of the average child. It is in the hope of encouraging such private research that I have ventured to append this lengthy and somewhat technical survey of the subject.

[1] Thorndike has proposed a simple 'parabolic curve,' showing 'a negative acceleration from the age of 6½' and a 'not inappreciable gain until 18 or later' (*Mental Measurement*, pp. 466–7, Fig. 64). But a logistic curve seems to give a better fit both to his assumptions and to his data.

APPENDIX III

STATISTICAL CRITERIA

IN researches on individual psychology it is continually necessary to determine the connexion between two characteristics of a group—for example, between children's intelligence, on the one hand, and their height, on the other. Now in most of these inquiries the data are obtained in the form of a double list—two measurements for each individual. Between the two lists of figures the degree of correspondence can then be assessed by the method of correlation, and the coefficient computed by one of the familiar formulæ—by product moments or by rank-differences.

But in many inquiries, and for a large number of the characteristics discussed in this volume, no graded measurements are available for the several individuals. The children are simply grouped into opposite categories, first for one characteristic and then for the other: *e.g.* backward and not backward, deaf and not deaf. If we attempted to set the data down in the form of a correlation table for each factor, we should find only four subdivisions. As an example take the first batch of 100 cases to be examined in this inquiry—comprising 50 backward children and 50 not backward (Table XXXII). Among these the commonest physical defect was partial deafness. There were 10 instances of defective hearing, grave or mild, among the backward, but only 3 among the non-backward. The problem at once arises: can we, with groups so small, infer a definite con-

TABLE XXXII. FOURFOLD TABLE SHOWING ASSOCIATION BETWEEN DEAFNESS AND BACKWARDNESS

		Educational Attainments.		Total.
		Not Backward.	Backward.	
Hearing	Not Deaf	$47 = q$	$40 = s$	$87 = Q$
	Deaf .	$3 = p$	$10 = r$	$13 = P$
Total . .		$50 = n$	$50 = m$	$100 = N$

nexion between partial deafness, on the one hand, and backwardness in school work, on the other ?

This is an exceedingly common form for the data to assume whenever we are investigating the influence of an alleged causal factor by means of what is ordinarily termed a control group.

The first and the most usual step is to equalize the numbers in the two main groups, if this has not already been done.[1] For this purpose the obvious device is to express the proportional amount of defect in each group as a percentage (Table XXXIII).

TABLE XXXIII. INCIDENCE OF DEAFNESS AMONG THE NORMAL AND THE BACKWARD

	Normal.	Backward.	Difference.
Deaf .	6 per cent. $= p_1$	20 per cent. $= p_2$	+ 14 per cent.

Percentages on this basis have been tabulated in the text for all the conditions recorded in the backward and the control groups respectively. The difference between the two percentages is then the crucial figure ; and in many published reports no further statistical criteria are applied.

Can we, however, without more ado, validly treat this percentage-difference as revealing both the presence and the amount of a correlation between the two conditions studied ?

A. The Existence of a Significant Difference

1. *The Probable Error as Deduced from Normal Distributions.*— When we take small samples, containing 50 or 100 children, from the total population, we cannot expect *precisely* the same proportion of defect in each, even if the defect is in fact wholly irrelevant to the basis of selection. Slight fluctuations are bound to arise by what is loosely called sheer chance. How large, then, must the difference be before it can be regarded as statistically significant ? With any given percentage or proportion, the error of sampling—which is usually taken as equivalent to the ' standard deviation ' or (as it is termed in this context) the ' standard error '—can be estimated by the simple formula—

$$\sigma_1^2 = \frac{p_1(1 - p_1)}{n}, \text{ or } \frac{p_1(100 - p_1)}{n} \text{ if in percentages,}$$

[1] Had we examined a whole school or a whole educational area, the backward cases would probably have formed only one-tenth of the whole ; so that the totals in the two divisions would have been different—500 and 50, say, instead of 50 and 50.

where p_1 denotes the proportion or percentage of the first group showing the characteristic in question (*e.g.* in Table XXXII, the proportion of normal children who are deaf) and n denotes the number in the group or 'sample.' σ_2, the standard error for the second percentage, is found in the same way. The 'standard error' of the *difference*[1] between two such percentages will then be—

$$\sigma_{\text{diff}} = \sqrt{\sigma_1^2 + \sigma_2^2}$$

What is called the 'probable error' is, with a normal distribution, ·6745 × the standard error; and, by the customary criterion, to be statistically significant,[2] a difference must be at least three times its probable error, *i.e.* about twice its standard error. Assuming a normal distribution, the probability that a difference of this magnitude and in this direction (*i.e.* *above* the figure for the control group) is due to chance—a probability for which I shall use the symbol P′—is ·0215135, *i.e.*, about 2 in 100: this is commonly taken to mean that the odds are 98 to 2 against a chance hypothesis. If we desire to test mere independence—*i.e.* the likelihood of a difference of this size *regardless* of direction (the commoner issue), then we must take $P = 2\ P'$. Thus the borderline figure for P—the probability of independence—will be about 4 in 100 (roughly 22 to 1 against).

On applying the above formula to the figures given in Table XXXII for deafness, we find the probable error of the difference observed to be 4·44 per cent., or 2·22 out of 50. The observed difference is 14 per cent. or 7 out of 50. Hence it definitely passes the customary test. Using the ordinary tables for the frequency of deviations distributed according to the normal curve, we find that the probability of so large a divergence in this direction arising by pure chance is $P' = ·017$, that is, about 1 in 60.

When figures for a long series of characteristics have to be compared, it is simpler to calculate, for percentages taken at regular intervals, what difference will be significant, than to calculate afresh

[1] Teachers attempting investigations of their own, however, should refer to a standard textbook of statistics (*e.g.* Yule and Kendall, pp. 360, 388, 442; with *graded* measurements σ_{diff} should be calculated directly from the observed differences. This is equivalent to deducting $2r_{12}\sigma_1\sigma_2$ — an important precaution with control-groups based on matched pairs. But in the problems here discussed r_{12} may be taken = 0).

[2] This does not mean that smaller differences have no theoretical interest whatever. They may give *indications* of a genuine difference, but cannot be regarded as amounting to *proof*. With a difference that is only twice the probable error the chances are still 82 to 18 (nearly 5 to 1) against its being an 'error.' With a difference that is equal to the probable error the chances are 50 to 50: hence the name '*probable* error.' Comparisons would be much simpler if psychologists would now drop the probable error and use the standard error (*i.e.* the standard deviation) instead, taking some round value such as $P = ·05$ ($P' = ·025$) as the borderline instead of the awkward fraction which corresponds to 3 times the probable error, namely, $P = ·043027$ . . .

for every pair of ascertained percentages what may be the difference between each, and what is its precise significance. Taking p'_2, the minimum percentage that is statistically significant, as equal to $p_1 + 3 \times \cdot 6745\, \sigma_{\text{diff}}$, the above formula yields the following equation:

$$p'_2 = \frac{1 + \cdot 4885 n p_1 + \sqrt{1 + 4(\cdot 4885 n + 1) p_1 (1 - p_1)}}{\cdot 4885 n + 2}$$

When neither n nor p is small, a significant difference $(p'_2 - p_1)$ is approximately equal to—

$$2\sqrt{\frac{2p_1(1 - p_1)}{n}}$$

a rough but ready formula which can be deduced directly from the above equation for the standard error of the difference.

For the Birmingham groups, $n = 196$, and, for the London groups, $n = 391$. With groups of this size, therefore, and according to this criterion, the percentages that are just significant will be of the following order, as shown in columns 1, 2, and 5 of Table XXXIV.

TABLE XXXIV. MINIMUM SIGNIFICANT DIFFERENCES BETWEEN CONTROL GROUPS AND BACKWARD GROUPS

Control Group.	Backward Group. (London Inquiry.)			Backward Group. (Birmingham Inquiry.)		
Percentage showing Defect.	Based on Normal Distribution.	Based on Double Sampling.	Based on Single Sampling.	Based on Normal Distribution.	Based on Double Sampling.	Based on Single Sampling.
Col. 1.	Col. 2.	Col. 3.	Col. 4.	Col. 5.	Col. 6.	Col. 7.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0·0	1·04	1·28	1·31	2·05	2·51	2·58
0·5	2·15	2·36	2·38	3·26	3·70	3·76
1	3·03	3·23	3·25	4·25	4·66	4·72
2	4·57	4·75	4·77	5·98	6·35	6·41
3	5·99	6·15	6·16	7·54	7·89	7·95
4	7·34	7·50	7·51	9·02	9·35	9·41
5	8·64	8·79	8·81	10·42	10·75	10·80
10	14·75	14·89	14·90	16·94	17·23	17·27
15	20·52	20·65	20·66	22·97	23·22	23·26
20	26·08	26·19	26·20	28·73	28·94	28·97
25	31·50	31·59	31·60	34·29	34·47	34·49
30	36·81	36·97	36·98	39·69	39·84	37·86
50	57·20	57·20	57·20	60·16	60·16	60·16

Thus, although many of the differences observed at Birmingham are larger than those observed at London, and may even (like left-handedness) produce larger correlations with backwardness, never-

theless the Birmingham group is so small that the results there ascertained can carry no great conviction by themselves: their value lies mainly in confirming in a different area what was observed on a larger scale in London. If a difference is statistically 'insignificant' (according to the usual convention) at both London and Birmingham taken separately, it may still be significant when both are taken together: *e.g.* if the probability of its being attributable to chance is, *at either place alone*, $P_1 = P_2 = \cdot 06$ (say), then the likelihood of its being found *in both samples concurrently* is $P_3 = \cdot 032$, which is 'significant.'

2. *The Square Contingency.*—There is an alternative criterion frequently employed by statisticians. Here, however, as we shall see, it leads to identical results.

Were deafness and backwardness entirely independent, we should expect to find the same proportion of deaf children among the backward group, among the normal group, and among the two groups taken as a whole. Accordingly, we can construct a theoretical table, based on these anticipations, and then test the table actually observed for the closeness with which it fits the theoretical. The general principle is to square the discrepancies in each section of the table in order to eliminate the algebraic signs, and then to express each squared discrepancy as a ratio of the corresponding theoretical frequency. The total amount of disagreement is computed by adding up these proportional squared discrepancies taken from every section of the table. The sum resulting, usually denoted by the symbol χ^2, is termed the square contingency.[1]

According to Professor Karl Pearson, this method, applied at the outset 'to throw out instances of unassociated data' before attempting to calculate the correlation by a definite coefficient, is 'the best method of inquiry for testing relative association in the case of fourfold tables.' Let us then apply this test to the figures given above for deafness and backwardness. With a fourfold table, except for reversals of sign, the crude discrepancy must be the same in every compartment. Accordingly—

$$\chi^2 = (10 - 6\cdot 5)^2 \left\{\frac{1}{6\cdot 5} + \frac{1}{6\cdot 5} + \frac{1}{43\cdot 5} + \frac{1}{43\cdot 5}\right\} = 4\cdot 34.$$

The table for the normal probability integral will show that, on the assumption of a random distribution (*i.e.* no correlation between

[1] The rough explanation of the arithmetical process given above does not follow the line of argument by which the formula has been derived; for this, see Yule, *Theory of Statistics*, 10th ed., Supp. IV, pp. 370 *et seq.*, and Karl Pearson's original memoir there cited. χ^2 is additive: hence, to obtain a combined probability (like P_3 above) we add the corresponding values of χ^2 and the number of degrees of freedom, and then find the value of P from these totals.

backwardness and deafness), P′, the probability of deviations from the expected figures as large as, or larger than, those actually observed, and in the same direction, would be ·018.[1] This is much the same low figure as before. In fact, if we take $p_1 = p_2 =$ average of observed values for p_1 and p_2 (duly weighted if based on different numbers), the ratio used in testing goodness of fit by means of χ^2 is algebraically identical with the ratio used in testing the probability of a difference between two proportions in the same table.[2]

Strictly, however, χ^2 is applicable only to a continuous distribution, whereas the frequencies in tables such as ours must, like all frequencies, jump by whole numbers from 9 to 10, and from 10 to 11, and so on. On a continuous scale, 10 would represent a range of 9·5 to 10·5. Accordingly, if χ^2 is to be used with these small numbers, we must try to correct for this discontinuity. It would be better to write the deviation to be squared (10·5 — 6·5) instead of (10 — 6·5). This yields a partial adjustment, tending, in point of fact, towards an over-compensation. It makes $\chi^2 = 3{\cdot}19$; which in turn yields P′ = ·0267—still a very low probability.

For purposes of computation the following formulæ are the quickest: $\chi^2 = \dfrac{(qr - ps)^2 N}{PQmn}$, or (correcting for continuity) $\dfrac{(qr - ps - \frac{1}{2}N)^2 N}{PQmn}$.

So far, it might be supposed, we may unhesitatingly conclude that deafness is associated with backwardness. But with percentages like those found in the present investigation a further difficulty arises. The formulæ given above, which represent the criteria almost invariably applied in such cases, assume, as we have seen, that accidental fluctuations in the percentages, and in their differences, follow the normal curve. Now, when the percentages themselves are low and the groups comparatively small, a little reflection

[1] Karl Pearson's 'Table for Testing Goodness of Fit' (*loc. cit.*, Table XII: 'Values of P for χ^2') should not be used here. 'n' in that table (number of cells or compartments in the table to be tested) assumes that the figures in each cell are independent of one another. Here, as we have noted above, only one compartment is free to vary: once that compartment is determined, the remainder can be deduced from the marginal totals for columns and rows. From the derivation of the formula it will be seen that the ordinary table for the normal probability integral can be used instead, taking $\frac{x}{\sigma} = \sqrt{4{\cdot}34} = 2{\cdot}08$.

[2] This method of analysis has been used in a recent research by Dr. N. J. England, Assistant Medical Officer, Holland (Lincolnshire) County Council. All the children over 9, attending eleven schools, were examined by means of my own group tests of intelligence and cross-classified for the physical defects, etc., usually recorded at medical inspections. Evidence for a significant association with poor intelligence was obtained only for poor nutrition, tonsillar disease, measles before school life, and bad family history; with other infectious ailments, bronchitis, rheumatism, chorea, fits, visual defects, etc., no significant association was found. ('The Relation between Health and Intelligence in School Children,' *Journ. Hygiene*, XXXVI, 1936, pp. 74–93.)

will show that this assumption may no longer be valid. Indeed, a symmetrical distribution with no limit either way to its range—such as the distribution implied by the normal curve—seems quite inadequate to represent the facts.[1]

3. *The Hypergeometric Formula from Double Sampling.*—It must be remembered that we are comparing our backward group, not with the normal population taken in its entirety, but only with a limited sample—the 'control group.' We have, therefore, to consider, not merely how far the figures from the backward may be disturbed by the errors of sampling, but also what margin of error may be expected in the figures from the control group. Where a normal distribution of errors can be assumed, the double sampling error is ordinarily allowed for by some such formula as that given above for the probable error of the difference; but when such an assumption is no longer permissible, some other mode of approach has to be tried.

The problem is of a type familiar in the history of statistics. The traditional instance is that of drawing black and white balls from an enormous urn, when the exact proportions of black to white are unknown and have first to be inferred by a preliminary sampling. In general terms the question to be solved is this. If, among the n balls drawn in the first sample, as many as p are found to be black and the remainder q to be white, what are the probable chances of finding r black balls on drawing a second sample of m?

The classical solution is well known, and leads to a hypergeometric series instead of the more familiar binomial. If we assume that, before the first sample has been examined, all the conceivable compositions of the urn or of the population were equally likely, then the probability of getting r black balls in the second sample after getting p black in the first will be—

$$\mathrm{P}' = \frac{m!}{r!\,s!} \cdot \frac{\sum_{x=0}^{x=1} \left\{x^{\mathrm{P}}\,(1-x)^{\mathrm{Q}}\right\}}{\sum_{x=0}^{x=1} \left\{x^{p}\,(1-x)^{q}\right\}}$$

[1] Where the average percentage approaches the midway figure of 50 per cent., the symmetrical binomial might serve to describe the accidental fluctuations arising in groups of limited size. But when the average percentage approaches zero, the binomial distribution becomes more and more asymmetrical. The mere smallness of the percentage, however, does not, as is so often supposed, obviate all valid comparison. We might, for example, try enlarging the control group. For the rarest conditions of all—*e.g.* epilepsy or organic heart disease—we might (if we could trust them) take the figures for the entire country as providing our control. In such cases the tabulated figures for the Poisson limit to the binomial might then be employed. In the future, it is to be hoped, with more uniform standards for medical inspections, trustworthy data of this sort will gradually become available. At present, standards vary too much for existing statistics to be used in this way.

where x = the proportion of black balls in the urn and the other symbols are as defined in Table XXXII. To evaluate this expression by direct algebraic methods is simple, but somewhat lengthy. If, however, N is so large that x can be treated as varying continuously from 0 to 1, we may substitute integration for the summation: the definite integrals that result take the form of Eulerian integrals, and the whole expression simplifies to—

$$P' = \frac{P!\,Q!\,m!\,(n+1)!}{(N+1)!\,p!\,q!\,r!\,s!}.$$

On slightly rearranging the terms and substituting the appropriate figures for r, the respective probabilities for $r = 0, 1, 2, \ldots m$ prove to be the successive terms of the following expansion:

$$\frac{(q+m)!\,(n+1)!}{q!(n+m+1)!}\left\{1 + \frac{m}{1!}\frac{(p+1)}{(q+m)} + \frac{m(m-1)}{2!}\cdot\frac{(p+1)(p+2)}{(q+m)(q+m-1)} + \ldots\right\}$$

where the sum in curled brackets forms the hypergeometric series $F(-m, p+1; -(q+m); 1)$.

Unless r is large, the sum required can be evaluated without much trouble.[1] As applied to the problem of the deaf and backward, the formula gives, for the probability of discovering 10 or more deaf children in a backward group of 50, when backwardness and deafness are assumed to be unrelated, a figure of ·03285, that is, about 1 in 30. This is nearly double the probability found by using the ordinary formula for the probable error of the difference, and the figures now no longer pass the criterion commonly imposed (see Table XXXIV). Taking the different values for p (expressed as a percentage of N (column 1)), I have calculated the resulting hypergeometric distributions; columns 3 and 6 give the minimum percentages that could be regarded as statistically significant upon this basis.

The assumptions underlying this solution, however, are not beyond criticism. It rests on what is generally known as 'Bayes' theorem' —though the present extension of it is mainly due to Laplace.[2]

[1] Greenwood (*loc. cit. inf.*, pp. 84–90) gives tables for use with small samples (up to $n = 100$, and $m = 50$; reprinted in Pearson's *Tables*, pp. 89–97), and he describes a method of computation by successive multiplication. Now, however, that tables of the logarithms of factorials have been republished (Pearson, *Tables*, pp. 98–101) the direct calculation of particular terms involves very little labour.

[2] For the history of the problem see Todhunter, *History of the Theory of Probability*, p. 383 and references. For the general use of the principle in modern statistical work see Karl Pearson, 'On the Influence of Past Experience on Future Expectation,' *Phil. Mag.*, XIII, 1907, pp. 365–78; for criticisms of it, see J. M. Keynes, *A Treatise on Probability*, 1921, pp. 367–83; and for empirical tests of it, see Egon Pearson, 'Bayes' Theorem in the Light of Experimental Sampling,' *Biometrika*, XVII, 1927, pp. 390–442; cf. also the earlier paper by M. Greenwood, *ibid.*, IX, 1913, 'On Errors of Random Sampling,' pp. 69–90.

The questionable point is the supposition that, before the first sample has been examined, all the conceivable compositions of the urn or of the population may be taken as equally likely : for, it is argued, if we are totally ignorant of the actual proportion, we have no reason to prefer one proportion to another. In practice, of course, we are never totally ignorant ; and, so far as human populations are concerned, it seems difficult to maintain that, *a priori*, any percentage of defect—from 0 to 100—is just as probable as any other. Nevertheless, in spite of the objections that have been repeatedly urged against the theorem, there can be little doubt that it yields a safer criterion for small groups and small percentages than the ordinary probable error of the difference. The question remains : can any better substitute be found ?

4. *The Hypergeometric Formula from Single Sampling.*—We may evade the difficulties involved by Bayes' theorem in the following way. To determine whether the percentages obtained from the control group and the backward group differ only by chance, it is not necessary to begin by treating both as samples of a vague and highly hypothetical ' total population,' and try first to estimate the ' true ' percentage in this ' total population ' from the percentage given by the control group—natural as that procedure might seem. We have a definite and limited population consisting of the two groups pooled together. Within this population we know precisely what are the proportions of deaf and non-deaf respectively. From the combined group of one hundred, then, we proceed to select 50 backward children. If backwardness and deafness are wholly unrelated, it follows that, in selecting the 50 cases, we are, so far as deafness is concerned, merely selecting at random. Thus, instead of dealing with two sampling processes, we have only to consider one.

So stated, the problem of sampling becomes far more straightforward. It is exactly analogous to that of drawing m balls simultaneously from an urn containing N, of which P are known to be black and Q to be white. The question is—what is the probability that r out of the m so drawn will be black ? To this simpler question a solution is easily obtainable.

On referring to Table XXXII it will become clear that the N individuals may be divided into two categories (not backward and backward), containing n and m in each, in $\frac{N!}{n!\ m!}$ ways. Quite independently, they may be cross-classified into two other categories deaf and not deaf), containing P and Q in each, in $\frac{N!}{P!\ Q!}$ ways.

And each of the former ways can be associated with each of the latter. Further, the number of ways in which the N individuals can be divided into four sub-groups (not backward but deaf, neither backward nor deaf, backward and deaf, backward but not deaf), containing the observed numbers p, q, r, and s respectively in each, is $\frac{N!}{p!\,q!\,r!\,s!}$. Hence P′, the probability of obtaining a table having these four observed numbers out of all the possible fourfold classifications, is [1]—

$$P' = \frac{\dfrac{N}{p!\,q!\,r!\,s!}}{\dfrac{N!}{n!\,m!} \times \dfrac{N!}{P!\,Q!}} = \frac{P!\,Q!\,n!\,m!}{N!\,p!\,q!\,r!\,s!}$$

It follows that the probabilities for $r = 0, 1, 2, \ldots P$ will be given by the successive terms in the expansion of—

$$\Sigma\left\{\frac{(N-m)!\,m!\,P!\,Q!}{N!\,(P-r)!\,(Q-m+r)!\,r!\,(m-r)!}\right\}$$

$$= \frac{(N-m)!\,Q!}{N!\,(Q-m)!}\left\{1 + \frac{m}{1!}\cdot\frac{P}{Q-m+1} + \frac{m(m-1)P(P-1)}{2!\,(Q-m+1)\,(Q-m+2)} + \ldots\right\}$$

where the sum in curled brackets forms the hypergeometric series $F(-m, -P\,;\, Q-m+1\,;\, 1)$.

The odds in favour of a chance explanation are therefore given by summing the tail end of the resulting hypergeometric series; and,

[1] Or, if we find it easier to picture the children as balls in an urn, we may argue: r black balls may be obtained out of a total of P black balls in ${}_PC_r$ ways; $(m - r) = s$ white balls may be obtained out of a total of Q white balls in ${}_QC_s$ ways; and m balls altogether may be obtained out of a grand total of N in ${}_NC_m$ ways. Hence—

$$P' = \frac{{}_PC_r \times {}_QC_{m-r}}{{}_NC_m}$$

which reduces to the same result as before.

The above expression reduces to the expansion of the binomial $\left(\frac{P}{N} + \frac{Q}{N}\right)^m$, when N, P, Q are so large in comparison with m and r that the withdrawal of m, r, and $m - r$ balls leaves N, P and Q unaffected; for, when the balls are not replaced, the probability of drawing r black balls in succession is $\frac{P(P-1)\ldots(P-r+1)}{N(N-1)\ldots(N-r+1)}$, and when P is very large compared with r, this becomes approximately $\left(\frac{P}{N}\right)^r$, which is the probability of drawing r black balls in succession when each is at once replaced; and similarly for the factor containing Q. When $\frac{P}{N} = \frac{Q}{N} = \frac{1}{2}$, the binomial becomes symmetrical; and, when r in turn becomes very large, the discontinuous expansion approximates to the normal curve. Thus our present formula is really a more general form of that given above on the assumption of a normal distribution.

for the case in question, where r, the number of children who are both backward and deaf, $= 13$, we have

$$P' = \frac{13!\ 87!\ 50!\ 50!}{100!} \sum_{r=10}^{r=P} \left\{ \frac{1}{(13-r)!\ (50-13-r)!\ r!\ (50-r)!} \right\}$$

Using a table of factorials the sum can be evaluated even more quickly than before; and we find P′, the total probability, $= \cdot 03565$, or about 1 in 28.

This is a still higher value than the preceding. On this basis, therefore, and with groups so small, we can no longer regard the difference as statistically significant. The odds certainly are somewhat against the hypothesis that deafness and backwardness are wholly independent; but the hypothesis of chance is by no means ruled out.

Here, then, is the criterion I suggest for use when the groups investigated are comparatively small. Now it will be remembered that, in the first hundred cases to be studied, partial deafness appeared to be the defect showing the closest relation of all to educational backwardness. Accordingly it becomes obvious that a batch containing only a hundred cases would be far too few for any conclusive deductions to be drawn either about this or any other condition whose frequency is so low.

I have given the results obtained by this new formula[1] in columns 4 and 7 of Table XXXIV. The figures[2] make it clear that, when we take groups comprising two to four hundred, then, except for the percentages that lie very near the zero end, the results of the two hypergeometric criteria become almost identical, and neither diverges very far from that obtained by the more usual criterion. This entirely relieves us from the fear expressed above, namely, that, with small percentages such as those obtaining in the present investigation, the abnormal distribution of sampling errors might vitiate all comparisons. Caution, however, is still requisite near the zero level. Here, although the significant percentages as printed in the table look very little larger when based on the hypergeometric formulæ, nevertheless a criterion based on the 'normal' formula

[1] The foregoing paragraphs were written, and the calculations they describe carried out, before the publication of the new (fifth) edition of Fisher's *Statistical Methods for Research Workers*. This now contains an added section on 'the exact treatment of 2 × 2 tables' (sect. 21·02, pp. 99–101). A similar formula is proposed, though somewhat differently derived. The reader should refer both to the argument and to the illustrative example.

[2] It is evident from its derivation that this criterion should be used, not with percentages which imply that the series of frequencies is virtually continuous, but with the actual frequencies expressed in the original integral units. Nevertheless, for purposes of comparison I have translated the results into terms of a continuous percentage scale. This has been effected by inverse interpolation carried far enough to ensure accuracy in the second decimal figure.

would make a chance explanation seem twice as improbable as does the criterion now proposed.

In the text I have only cited P′ for cases near the borderline of significance. For the rest I have indicated where the difference was below the level of significance (as judged by the ' single sample criterion ' in the few instances where the choice of criterion would have altered the result) by placing brackets round the coefficient of correlation deduced from the figures in question. The general result is that in the tables showing the differences between normal and backward children at Birmingham rather less than one-third of the differences are significant ; at London just over one-half. ' Significance,' however, is a relative term ; and, no matter what the basis of the criterion, the borderline drawn is purely conventional. Hence for cases near the borderline I have cited the actual value of P′ in the text.

One further caution must be added. The values so reached for P′ merely give the odds in favour of chance in the strict interpretation of that term. The errors and fluctuations taken into account are those that arise from ' random ' sampling only. In practice, no form of actual sampling, not even that obtained in tossing dice or drawing shuffled cards, is perfectly ' random ' in this abstract sense. In the past the psychological investigator has been too apt to suppose that, in eliminating the influence of ' chance ' as the mathematician understands it, he has also eliminated the effects of all accidental or irrelevant factors.

Moreover, if we adopt the single-sample criterion, all we have proved is this : that *with the two batches of children actually compared* the division into deaf and not deaf has not arisen by chance, but is in some way related to the cross-division into backward and normal. It does not follow that there would be a similar relation between backwardness and deafness in other batches or in the population at large.

Bayes' theorem attempts to combine two problems in one. There is first the statistical question : can the figures actually observed be explained by the chances of random sampling ? There is secondly the inductive problem : granted that the differences between the two samples actually observed cannot be attributed to chance, can we generalize this result, and conclude that deafness as such, anywhere and everywhere, tends to be accompanied by backwardness ?

The formulæ dealing with ' random ' sampling—or ' simple ' sampling, as it has been less ambiguously termed—assume that the fundamental probabilities or proportions, estimated by p_1 or the

average of p_1 and p_2, are stable : that is to say, that the probability of a normal child being deaf is the same at one date and place as at another, the same in the slums as in well-to-do areas, the same for older children as for young. Actually, however, such factors as age, sex, and locality are bound to introduce extraneous influences. In the tables in the text I have always given separate figures for the two sexes ; the divergences, though occasionally significant, are seldom large. The effect of age I have not been able to study. The most valuable evidence for comparative stability is to be seen in the way in which the data obtained in London and Birmingham respectively lead to very similar results. When we find that the figures in both inquiries are, for the same defects and in much the same degree, inexplicable by chance, we may, I think, fairly infer that some general connexion is operative throughout. Although the absolute percentages are not precisely the same, the differences between the percentages show much the same relative character.

B. Amount of Correlation

The foregoing criteria may be used to test the *presence* of an association between backwardness and any supposed contributory condition: to measure its *amount*, a further calculation will be necessary. In psychological inquiries the tendency towards concomitant variation is usually measured by a fractional index, varying from -1 through 0 to $+1$, called a coefficient of correlation (see *supra*, p. 109, footnote 1).

1. *The Product-Moment Coefficient.* Suppose, first, that the two characteristics—intelligence and height, for example—have been measured on a continuously graded scale. A coefficient of correlation can then be calculated by the formula

$$r_{xy} = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

where x and y are the measurements to be correlated (expressed as deviations from the average), r_{xy} the correlation between them, N the number of children in the group, σ_x and σ_y the standard deviations of the two series of measurements.[1] The probable error may be taken to be $\pm\ 0{\cdot}6745\ \frac{1 - r^2_{xy}}{\sqrt{N - 1}}$.

2. *Rank-Differences Coefficient.* Or the children may be simply ranked in order of merit for the two characteristics to be compared.

[1] For examples, see pp. 91, 94, 100–3, 121, 137–9, 151, 153, 446, 449. For the conditions implied in the use of this and the following formula, see Kelley, *Statistical Method*, pp. 151 *et seq.*, Fisher, *Statistical Methods for Research Workers*, pp. 160 *et s*

A coefficient can then be computed from the sum-total of the rank-differences (d), *viz.*:

$$R_{xy} = 1 - \frac{3\Sigma d}{N^2 - 1}$$

$$r_{xy} = \sin\left(\tfrac{\pi}{2} R_{xy}\right) \text{ approximately.}^{1}$$

3. *Product-Moment Formula with a Fourfold Table.* Even if we have no detailed measurements for every child, but only a two-fold grouping (as in Table XXXII above), we may still apply the product-moment formula. If we allot 1 mark for the presence of a characteristic (*e.g.* normal hearing or normal attainments) and 0 marks for its absence, we obtain

$$r_{xy} = \phi = \frac{\chi}{\sqrt{N}} = \frac{qr - ps}{\sqrt{PQmn}} = \frac{qN - Qn}{\sqrt{PQmn}}.$$

The deduction implies that each set of frequencies is concentrated at a single point. This holds good of sex, and presumably of unit-characters (in the Mendelian sense). It does not hold of the majority of the causal conditions, physical or mental, considered in this work.

4. *The Coefficient of Colligation.* In passing let us note that, if the relative size of the control-group varies from one characteristic to another, that of itself will influence the size of the correlation coefficient calculated in this way. We may, however, equalize the subtotals in the fourfold table by multiplying the first row, second row, first column, and second column respectively by

$$\sqrt[4]{\frac{pr}{qs}}, \quad \sqrt[4]{\frac{qs}{pr}}, \quad \sqrt[4]{\frac{sr}{pq}}, \quad \sqrt[4]{\frac{pq}{sr}}.$$

We then have [2]

$$P = Q = m = n = \tfrac{1}{2} N, \text{ and } r_{xy} = \frac{\sqrt{qr} - \sqrt{ps}}{\sqrt{qr} + \sqrt{ps}}.$$

5. *Normal Correlation Coefficient for Equally Divided Fourfold Tables.* If we have reason to believe that the characteristics are really continuously graded and that the division into two groups is arbitrary, then the last two formulæ are not strictly applicable. The distribution of intelligence and of educational attainments is not

[1] Tables are available for effecting this conversion: *e.g.* Whipple, *loc. cit.*, I, p. 44, Table 6. (The second edition gives Pearson's more exact conversion formula.)

[2] Yule, 'Methods of Measuring Association between Two Attributes,' *Journ. Roy. Stat. Soc.*, LXXV (1912): cf. *id. Introduction to Statistics*, p. 39. In an early publication I suggested that this formula was perhaps the handiest for 'item-analysis' and employed it for assessing the relative efficiency of the component tests in the Binet scale (cf. *Mental and Scholastic Tests*, 1921, pp. 197–205, where a graph is given for reading off the coefficient from the percentages observed); at the same time I pointed out that it seemed suited only for rough preliminary inquiries, and that, for more exact research, it would be better to use internally graded measurements and the product-moment formula if possible, or else to calculate the tetrachoric correlation.

only continuous, but also, as I have elsewhere shown, approximately normal. In the absence of more precise knowledge, the same may be assumed of most other physical and mental characteristics. As before, we may consider two cases: (*a*) when both sets of measurements are divided at the average or median, so that all four subdivisions have equal subtotals, and (*b*) when they are not.

(*a*) In the former case a simple formula may at once be deduced. The equation to the correlation surface will be

$$z = \frac{1}{2\,\pi\sqrt{1 - r^2}}\,e^{-(x^2+y^2-2rxy)/2\,(1-r^2)}$$

Its contours will be elliptical, with major and minor axes proportional to $1/\sqrt{1-r}$ and $1/\sqrt{1+r}$ respectively. Regarding the ellipses as projections of the circle produced when the correlation is zero, we find, by elementary geometry,

$$r = \sin\frac{\pi}{2}\cdot\frac{\sqrt{qr} - \sqrt{ps}}{\sqrt{qr} + \sqrt{ps}} \text{ or } \cos(2\pi\,.\,s/\mathrm{N})$$

where s/N is half the proportionate number of children showing 'unlike signs,' *i.e.* combining the presence of one characteristic with the absence of the other. It will be noted that, with equally divided fourfold tables, the coefficient of colligation and the normal correlation coefficient are related to each other much as the footrule coefficient and the product-moment coefficient, when fully graded distributions are used.[1]

6. *Tetrachoric Correlation.* (*b*) In most of the cases here investigated, the numbers of the subtotals are not, and cannot be, equalized. The normal correlation surface is then divided by the fourfold tabulation into four quadrants by two vertical planes which are at right angles to the axes of x and y, and which no longer pass through the origin of these axes (the averages) but are placed at distances of (say) x' and y' from the origin.

We then have

$$\frac{q}{\mathrm{N}} = \frac{1}{2\pi\sqrt{1 - r^2}}\int_{x'}^{\infty}\int_{y'}^{\infty} e^{-(x^2+y^2-2rxy)/2\,(1-r^2)}\,dx\,dy.$$

By expanding the exponential part in a power series by Maclaurin's theorem, we can convert this equation into a form enabling us to determine r from q instead of q from r. We ultimately obtain

$$\frac{q\mathrm{N} - \mathrm{Q}n}{\mathrm{N}^2.\,z_{x'}z_{y'}} = r + \frac{r^2}{2!}x'y' + \frac{r^3}{3!}(x'^2 - 1)(y'^2 - 1) + \ldots = \sin^{-1} r \text{ (approx.)}$$

where x' and $z_{x'}$ and y' and $z_{y'}$ are the deviations and ordinates cor-

[1] A table for deducing r from s is given by Whipple, *loc. cit.*, p. 51. Or, if s is expressed as a percentage, we have $r = \cos s\ 3{\cdot}6°$; and the values can then be read from an ordinary trigonometrical table.

responding to n/N and Q/N respectively and can be obtained from the usual table of the probability integral, and where the factors containing x' and y' are the successive Hermite polynomials (or 'parabolic cylinder functions' as they are sometimes termed) and can be obtained from the published tables of the tetrachoric functions.[1] If r is required correct to two or three places only, the equation can readily be solved by Horner's method.

When the tetrachoric coefficient is approximately zero, its probable error is

$$\pm \frac{0{\cdot}6745}{z_x z_y}\sqrt{\frac{\mathrm{PQ}mn}{\mathrm{N}}}.$$

A word of caution must be added. A correlation is not a measurement of a physical fact, and by itself affords no evidence of a causal relation. The results of such calculations provide a check and a safeguard against erroneous conclusions rather than a positive and self-sufficient proof of the true conclusion.

Take, for example, the figures for (i) adenoids, (ii) marked defects of vision, (iii) marked defects of hearing—30, 18, and 6 per cent. respectively among the backward.[2] Those who overlook the need for a control group almost invariably take such figures to indicate, just as they stand, the relative importance of the causative factors. Those who realize the need for comparing the figures for the backward with those for the general population usually take the differences between the two percentages, here 15, 6, and 5 per cent. respectively. The tetrachoric correlations, however, are ·28, ·14, and ·44—which suggest a very different conclusion, and one far more in keeping with the natural impressions of the teacher. A more accurate measure of correlation would be procured if we could grade the defects according to their severity (*e.g.* by applying tests of visual and auditory acuity, and the like) in the way we grade intelligence, etc., by means of a mental ratio. Could we show that the removal of the handicap, *e.g.* by the provision of spectacles or an operation for adenoids, is followed by a significant improvement of educational attainments, a causal relation, as well as a statistical,

[1] Pearson, *Tables for Biometricians*, Vol. II, pp. 78–137. For determining tetrachoric correlations from the observed percentages, with one division at 10 per cent., my wife has worked out graphs, analogous to that given in *Mental and Scholastic Tests* (p. 219) for the coefficient of colligation. Thurstone has since published a set of graphs, for all divisions from 1 per cent. to 50 per cent., but on a somewhat smaller scale (*Computing Diagrams for the Tetrachoric Correlation Coefficient*, Univ. Chicago Bookstall, 1933). All our published coefficients have been calculated out by the full method; we have used the graphs only as a check or for a preliminary determination of a coefficient to discover whether or not a full arithmetical calculation was worth while.

[2] Table XIII, p. 165.

would then be demonstrated.[1]

But the questions here investigated form part of a problem which is even wider still—namely, the causes of mental variability in general. In their examination of such topics, teachers, doctors, and investigators generally are still disposed to remain content with the calculation of isolated correlations. But the conditions affecting the results are, in most instances, too numerous and too closely linked to be completely disposed of in that simple way. There are three related techniques that may be found helpful. (i) Pearson's method of *multiple correlation* is the oldest, and has formed the starting-point of the more complex techniques used in psychology. Newer developments in statistical method, however, suggest that multiple regression rather than multiple correlation is the basic concept, and that correlation should be regarded merely as a special case of co-variance. (ii) Since the chief problems in educational psychology are problems in the analysis of individual variability, the fundamental technique should really be some form of what is known as *analysis of variance and co-variance*. Unfortunately, owing to its comparative novelty, the details of this mode of analysis still remain unfamiliar to most educationists. Nevertheless, it is a technique which is of especial value where the investigator's task is to assess the effects of treatment or training. In the near future it will doubtless come more and more into use in inquiries into the results achieved with different methods of dealing with backward and subnormal children. (iii) *Factor-analysis* may be regarded as a particular development of these two fundamental procedures. Historically it emerged as a special case of the multiple correlation problem ; but later developments indicate that it is in its essential character a method of analysing variance with weighted instead of unweighted means. Since so many of the assumptions made in the foregoing pages rest upon, or require verification by, factorial analysis, it has been suggested that a brief account of its aims and methods should be appended for the benefit, not only of those teachers who wish to undertake researches of their own, but also of

[1] Even here a good deal of caution has to be observed. In a recent analysis of the subsequent histories of my cases, I found small positive correlations (·14 and ·18) between an operation for adenoids, on the one hand, and general intelligence and educational attainments, measured *before* the operation, on the other : and from the case-records it appeared that the parents of the bright or normal child were generally more prompt to carry out the recommendations of the doctor who had advised such an operation. Thus, it would seem that the dull children are more frequently found suffering from adenoids, not so much because adenoids produce dullness in the child, but because, owing to the dullness of the child's own parents, such troubles are less likely to be dealt with while the child is still young. I do not put this forward as the sole explanation, but merely to illustrate the variety of ways in which a correlation may be interpreted even when it has been satisfactorily established.

those who wish to follow articles on educational problems in which factor-analysis has been employed.[1]

C. Factor-analysis

The General Factor.—The elementary notions on which factor analysis is based are familiar to every teacher, though he does not think of them as part of a statistical technique. To begin with, most teachers believe that all the ordinary subjects of the school curriculum (reading, writing, arithmetic, etc.) form a related class of activities which depend (no doubt in differing degrees) upon a *common causal factor*, *viz.* a general intellectual capacity, popularly termed intelligence. This is borne out by the fact that, during the elementary school stage, practically all pupils can be assigned to the same class or standard for every subject : the child who is backward appears backward all round ; and the mentally defective are defective in every form of mental work.

Nevertheless, in the past a number of psychologists were inclined to question[2] this assumption of a 'general factor.' Hence a scientifically devised procedure became necessary to verify or correct this and other related hypotheses. (i) To investigate how far the

[1] On analysis of variance, see Fisher's *Statistical Methods for Research Workers* (1934). Fisher's introduction to the method (*loc. cit.*, pp. 212f.) yields a simple way of relating the three alternative procedures described above. He begins by showing how an intra-class correlation between members of the same family can be expressed in the form $r = C/(C + S)$, where C = the *theoretical* variance of the common factor (*e.g.* heredity) and S the variance of the factors specific to either correlated variable. He then relates the square-sums (on which the *observed* variances are based) to the hypothetical by two simple equations (p. 213). Now, if we solve these for the *theoretical* variances, we obtain $C = \frac{1}{2}(\sigma^2_b - \sigma^2_w)$ and $S = \sigma^2_w$, where σ^2_b and σ^2_w = the variances 'between' and 'within' groups respectively. This final step—which I call the 'factorial analysis of variance'—can be generalized and extended to several factors. Incidentally it shows how 'reliability' can be calculated in terms of variances. The following discussion is based mainly on the Appendix to my L. C. C. Report on *The Bearing of Factor Analysis on the Organization of Schools and Classes* (1923). The arguments themselves owe much to the criticisms of Dr. W. F. Sheppard, one of His Majesty's Inspectors of Schools, a prominent member of the Child Study Society, and himself a statistician of international repute. The researches of teachers and others in this field are deeply indebted to him, not only for his personal influence with the central and local authorities, but still more for his helpful criticisms and suggestions, which combined statistical knowledge with practical experience.

[2] In this country the earliest and most outspoken critics were William Brown and Godfrey Thomson, but their later pronouncements have been far more favourable. The reader will find the answers of leading educationists and psychologists to this question collected in the Board of Education *Report on Psychological Tests of Educable Capacity* (1924), Appendix IX. In America, Thurstone declares that 'so far in our work we have not found the general factor,' and holds that the assessment of a child's general intelligence by a single index, such as mental age or I.Q., obscures the fact that primary abilities are of different kinds. The issue has recently come to be of considerable practical importance, since many educational reformers in this country hold that the attempt to classify children primarily in terms of innate general ability is mistaken, and should be replaced by a scheme for classifying them solely according to their suitability for the work of grammar, technical, or modern schools respectively.

primary assumption of a general factor can be justified, the first step is obviously to correlate marks or measurements for all school subjects, and observe whether the correlations are uniformly positive and reasonably high. (ii) To measure the common factor entering into all such subjects (if its existence is established) the natural procedure would be to add or average the marks obtained by each child in all the subjects. (iii) To ascertain whether certain subjects (*e.g.* composition or problem arithmetic) depend more closely than others (*e.g.* drawing or handwork) on this general factor, we should naturally calculate the correlations of each subject with the hypothetical ability as provisionally estimated from the averages. And finally (iv), if these correlations varied appreciably, then we should feel that, before adding or averaging, we ought to allot a higher weight to the more important subjects, and should probably take the correlations (or some function of them) as an indication of the relative weights to be assigned. Factor-analysis, in its simplest form, is merely a mathematical technique for applying these principles and carrying them to their logical conclusions.

The Special Factors.—Nearly all teachers also believe that certain children owe their backwardness, not so much to a lack of innate *general* ability, as to a deficiency in some kind of *special* aptitude. This child, bright enough in other respects, suffers from a poor memory ; that child seems to show a number-gap ; a third, though good in arithmetical and practical work, is hopeless at all verbal subjects—reading, spelling, and composition ; while a fourth is exceptionally clumsy in writing, drawing, and handwork. The natural inference drawn by educational writers was the existence of something very like the old-fashioned faculties—special factors (as we should now call them) for memory, for verbal subjects, for number, for manual dexterity, and the like. But once again, such inferences have been strongly contested by academic psychologists, notably by Spearman and his followers.[1]

Here too, therefore, a statistical technique is needed to check these further assumptions and, if they are verified, to measure the special abilities or disabilities so indicated. The method is simple. We have merely to partial out the influence of the first or general factor, and the analysis then follows much the same lines as before. Now, however, we are concerned with a specialized form of what

[1] The first to draw an explicit distinction between 'general ability' and 'special aptitudes' was Sir Francis Galton. Binet adopted a similar classification. Spearman held that 'special aptitudes' were little more than a survival of the 'antiquated doctrine of faculties' : the appearance of a 'special aptitude,' he maintained, was usually due to the effect of training or interest, and therefore did not represent a genuine ability (cf. *Abilities of Man*, ch. XV).

Pearson termed ‘ multiple correlation ’ : we are no longer seeking a single factor, but multiple factors.

The early work on factor-analysis was carried out chiefly by teachers and educationists working in London schools. And one of the main motives was to discover (i) whether there was a ‘ general factor,’ corresponding to what is known as intelligence, responsible for the general backwardness of the mentally defective and the dull, and (ii) whether there were in addition ‘ special mental factors ’ responsible for limited disabilities in those who are backward in some subjects but not in others.

Factors as Principles of Classification.—It is evident that the factorial methods will enable us not merely to classify mental and educational processes according to the abilities required, but also to classify the children. For such a classification to be economical, however, it is clearly desirable that the principles (*fundamenta divisionis*) on which it is based should be, so far as possible, independent of each other—*i.e.* that the factors, unlike the tests from which they are derived, should be uncorrelated. If, in young children, reading and spelling depend upon much the same capacity (verbal capacity, let us say), it would be foolish to classify such pupils first according to their proficiency in reading, and then again for spelling, with a view to sending them to different classes for each subject ; we should find in the end that (with very few exceptions) the classes would be the same.

And, in general, since all description is in effect merely a precise statement of the various classes or categories to which the individual described belongs, the first requisite of description in science is a set of *independent* principles of classification. But, as a rule, scientific descriptions do not merely allot classes on an all-or-none principle; they must include measurements. We do not merely say *that* a child's intelligence is defective, or *that* he is backward in verbal ability, as though mental deficiency was a specific disease and verbal disability a clear-cut form of aphasia (as, indeed, some early writers supposed) ; we seek to say *how* defective the child is, or *how* backward he appears. And the ultimate aim of what is known as multiple factor-analysis is to provide a comprehensive system of classificatory principles in the form of a multiplicity of appropriate factors, each admitting of *graded assessment.*

The Fundamental Factorial Equation.—These general requirements were first adumbrated by Galton, who perceived that they were an essential prerequisite to the adequate description of an individual personality. But the first to indicate how a precise mathematical technique could be developed was Karl Pearson.

Galton's postulates require us to base our classification on measurements whose 'correlations are as small as possible.' Pearson pointed out that, by using *combinations* of observed measurements instead of taking each observed measurement as it stands, we could secure a set whose intercorrelations were all *exactly* zero, thus carrying Galton's principle to its logical conclusion. In that case, the 'ideal index characters,' as Pearson termed them, would be *weighted averages*, calculated from the observed measurements by equations, which he expressed in the form :

$$\left.\begin{aligned} X_1 &= l_{11}x_1 + l_{12}x_2 + \ldots l_{1n}x_n \\ X_2 &= l_{21}x_1 + l_{22}x_2 + \ldots l_{2n}x_n \end{aligned}\right\} \quad . \quad . \quad . \text{(i)}$$
$$\ldots\ldots$$

where X_1, X_2, etc., denote the ideal index characters (or 'factors'), x_1, x_2, etc., the observed measurements, and l_{11}, l_{22}, etc., are 'numerical multipliers' (or 'weights') giving the 'directions' of the new 'dimensions' (or 'axes').

Now, as we have seen, the rough-and-ready practice of the teacher is to assess (i) the general ability of an individual pupil by simply adding or averaging his marks, and (ii) the pupil's relative superiority in this type of subject as compared with that, by simply taking differences between marks for different types of subject. And it is obvious that this simple procedure is equivalent to putting all the l's (in Pearson's equation) $= \pm 1$ (or $\pm 1/n$: $\pm 1/\sqrt{n}$ would perhaps be preferable on algebraic grounds). We should then have

$$\left.\begin{aligned} X_1 &= x_1 + x_2 + x_3 + x_4 \ldots \\ X_2 &= x_1 + x_2 - x_3 - x_4 \ldots \\ X_3 &= x_1 - x_2 + x_3 - x_4 \ldots \\ X_4 &= x_1 - x_2 - x_3 + x_4 \ldots \end{aligned}\right\} \quad . \quad . \quad . \text{(ii)}$$

and so on. With this simplification the correlations between the resulting 'index-characters' will be, not always zero, perhaps, but as a rule decidedly low, so that for practical purposes the characters selected may be regarded as virtually independent. But for scientific purposes, such a procedure is obviously somewhat crude. There are many possible ways of ensuring that the correlations shall be exactly zero. Pearson's suggestion was that we should take as the new 'dimensions' the 'principal axes of the correlation ellipsoid.'[1] The mathematical teacher, familiar with the elements of solid geometry,[2] will see that this suggestion at once reduces the factorial problem to a clear-cut issue with a well-known solution, and we

[1] *Biometrika*, I (1901), p. 209. For a fuller discussion of the problem in the light of Pearson's suggestions, see J. McMahon, *Biometrika*, XI (1923), pp. 194 *et seq.*
[2] *E.g.* W. H. Macaulay, *Solid Geometry*, p. 116.

may, I think, date the beginning of factor-analysis as a mathematical technique from this proposal of Pearson.

The Best-fitting Factors.—The advantages of the procedure may be simply explained. Suppose, first, that we are seeking a single common factor only (indeed, in the early days of factorial work, the sampling errors were usually too large for more than one to be determined): then the factor we should naturally choose would be that which gives the closest fit to the observed test-measurements (closest fit being interpreted as usual in accordance with the principle of least squares), or, as Pearson would have preferred to say, the factor which maximizes the multiple correlation—that is (to use more recent terminology) the factor which has the largest variance, *i.e.* which gives to the sum of the squares of its saturations the largest possible value. This is the factor which, geometrically, is represented by the largest axis of the ellipsoid. Now, it is easy to show algebraically that the factor which gives the best fit to the observed *test-measurements* is also the factor that gives the best fit to the observed *intercorrelations*. As a result, the arithmetical solution for the first factor becomes comparatively simple.

Next, suppose that we feel justified in seeking two factors: as our second factor we shall naturally choose the factor giving the best fit to the residual measurements left after we have eliminated the effects of the first factor, and this again can be found by fitting the factor to the residual correlations instead of to the residual measurements, and so on. The whole procedure is thus equivalent to maximizing the first, second, third . . . factor-variances in turn, and this is the same as minimizing the factor-variances of the last factor, then of the last two factors, then of the last three, and so on.

When we are dealing with a multiplicity of factors, the algebraic solution can be most succinctly expressed if we adopt matrix notation.[1] Let M be the correlated test measurements, P the uncorrelated factor-measurements (both in unitary standard measure), V the diagonal matrix of factor-variances, and L′ the weights or direction-cosines of the new reference axes. Then Pearson's initial equation may be written:

$$X = V^{\frac{1}{2}}P = L'M \qquad . \quad . \quad . \qquad \text{(iii)}$$

This expresses the factor-measurements as weighted sums of

[1] A glance at the original version of this argument (given in my Report, where summational notation was used for three variables only), will show how much is gained both in clarity and in generality by the adoption of matrix notation. The mathematical reader will find a convenient account of matrix theory in Bôcher's *Higher Algebra* (1907: cf. especially pp. 68, 285). The first to propose applying matrix methods to problems of multiple correlation was Dr. W. F. Sheppard, to whom I owe this suggestion.

the test-measurements, and, since L′ is an orthogonal matrix of direction-cosines, $(L')^{-1} = L$. Hence

$$M = LX = LV^{\frac{1}{2}}P = FP \text{ (say)} \quad . \quad . \quad \text{(iv)}$$

This enables us to express the test-measurements in terms of the factor-measurements, by using the same proportional weights transposed. Pearson's solution—namely, to adopt the principal axes as representing the factors—gives (according to a well-known theorem in multi-dimensional geometry)

$$VL' = L'R \quad . \quad . \quad . \quad . \quad \text{(v)}$$

where R will be the correlation matrix MM′ (with unity in the diagonals) and V and L the 'latent roots' and 'latent vectors' of R. To determine these constants we may then employ any of the recognized arithmetical procedures. Most of them involve a method of successive approximation.[1]

Weighted Summation.—A convenient method of computation can be derived in the following way. Suppose we take as our first approximation to the general factor-measurements for the several pupils the ordinary unweighted average (or sum) of their observed measurements; then the correlations of the several tests with the general average will usually differ. Accordingly, an improved fit will be obtained if we recalculate the averages (or sums) by weighting the measurements in proportion to the correlations thus obtained. But by altering the figures for the factor-measurements, we shall alter the resulting factor-correlations. Let us therefore recalculate these correlations and take their new values as improved weights. If we keep on like this, we shall eventually approach a set of correlations ($f_1, f_2, \ldots$, say) which are exactly proportional to the weights last used ($w_1, w_2, \ldots$, say).

Having thus finally calculated the first factor by weighted summation, we could subtract its effects from the observed measurements and apply the same procedure to the residuals. But with a large number of pupils this repeated recalculation of the factor-measurements for each individual would form an extremely lengthy process. However, a little algebra will quickly show that precisely the same figures will be reached if we proceed by weighting the rows

[1] Pearson's procedure (*Phil. Mag.*, II, 1901, pp. 569 f.) was devised for classifying persons according to their physical measurements. In adapting it to psychological measurements I found it necessary to introduce a 'unique factor' to allow for the disturbing and irrelevant 'errors' which are here much larger: this involved inserting 'reduced self correlations' in the diagonal of the matrix R. In such a case the principle of least squares requires the observed measurements to be first weighted in accordance with their 'precision', *i.e.* inversely as the 'unique factor.' The formulæ so reached are identical with those deduced from Fisher's principle of 'maximum likelihood,' but are too complicated for ordinary work.

of the correlation-matrix (R), instead of by weighting the rows of the observed measurements (M).

Our ultimate aim is to obtain (i) a matrix of factor saturations (F) giving the partial regression of the test-measurements on the factor-measurements, so that $M = FP$, and (ii) a matrix of weighting coefficients (W) giving the partial regressions of the factor-measurements on the test-measurements, so that $P = WM$. If P is in unitary standard measure, the correlations between the test-measurements and the factor-measurements will be:

$$MP' = FPP' = F. \quad . \quad . \quad . \quad \text{(vi)}$$

Normalizing the columns of F, we have $F = LV^{\frac{1}{2}}$, where V, as before, is the diagonal matrix of factor variances. The correlation matrix will then be:

$$R = MM' = FPP'F' = FF' = LVL' . \quad . \quad \text{(vii)}$$

It follows that its inverse will be $R^{-1} = (LVL')^{-1} = LV^{-1}L'$. But $F' = PM' = WMM' = WR$. So that

$$W = F'R^{-1} = V^{\frac{1}{2}}L' . LV^{-1}L' = V^{-\frac{1}{2}}L' = V^{-1}F'. \quad \text{(viii)}$$

(Of course, if we decide to extract as many factors as tests, F will be square; and the foregoing equation reduces at once to $W' = F^{-1}$.) Thus, on weighting the *rows* of the correlation matrix, we have $F'R = V^{\frac{1}{2}}L' . LVL' = V^{\frac{1}{2}} . VL' = VF'$. To calculate the first factor saturations we therefore take $f'_{1'} = v^{-1}(f'_1R)$, where f'_1 denotes the trial-values and $f'_{1'}$ the improved values. (Small letters in italic denote vectors, though v is a scalar; capitals denote matrices.)

Simple Summation.—Just as we can get a moderately good estimate of general ability by simply adding up the marks gained in each subject, so we can reach a fairly good approximation to the factor-saturations if we merely add the columns of the correlation table as they stand. When we come to the table of residual correlations, we can still adopt the same procedure. Simple summation is thus equivalent to taking the numerical values of all weights as equivalent to one; but, in dealing with the residuals, we must retain the plus or minus signs of the weights (with a clear-cut pattern of signs this is practically the same as disregarding all minus signs, as we do in calculating a mean deviation).

Significant Factors.—It will be seen that, when applied to the case of multiple factors, both the exact and the approximate solution virtually treat the observed correlation matrix as the sum of a series of rank-one matrices or 'hierarchies.' However, in dealing with human assessments, the irrelevant influences affecting single tests or traits are, as a rule, so large that only the first few common factors

22*

at most are likely to be genuinely significant.[1] Equation (vii), as deduced from Pearson's equation, then becomes :[2]

$$R = f_1 f_1' + f_2 f_2' + \ldots + f_n f_n' \qquad . \qquad . \qquad \text{(ix)}$$

$$= f_1 f_1' + f_2 f_2' + F_3 F_3' \text{ (say)} \qquad . \qquad . \qquad \text{(x)}$$

where $f_1 f_1'$ and $f_2 f_2'$ represent the effects of the two significant factors and $F_3 F_3'$ those of the non-significant factors. Now if the latter are not really significant, their only appreciable result will be to increase the test-variances to unity. Thus we may treat $F_3 F_3'$ as equivalent to a diagonal matrix D_3, say. In that case, what we require to analyse will be the reduced correlation matrix $R - D_3$, which can be formed from R by substituting the variance due to the significant factors only (the 'self-correlation' or 'communality') for the total variance of each test (which we have taken to be 1). These reduced variances can be readily estimated by successive approximation.

In the simplest case of all, where a single general factor alone is significant, we have merely to insert the estimated squares of the general factor saturations. The working procedure is therefore as follows. Having provisionally estimated these squares, we add the columns and divide by the square root of the grand total ; *i.e.* we take :

$$r_{ag} = \frac{\sum\limits_{i} r_{ai}}{\sqrt{\sum\limits_{i'}\sum\limits_{i} r_{ii'}}} \qquad . \qquad . \qquad \text{(xi)}$$

where r_{ag} denotes the correlation of any test (a) with the general factor (g)—that is, its 'factor saturation' (f_{1a}). This was the formula given in my 1917 *Report*, where I analysed the factors deducible from the correlations between the subjects of the elementary curriculum. It has since been adopted by Thurstone.

The result of inserting the squares of saturations instead of unity is quite simply explained. If we regard all the factors as non-significant except the first, we shall be concerned solely with the first equation in Pearson's set ; and if we further regard the differences between the weights, $l_1, l_2, \ldots l_n$, as unimportant and put each $= 1$, then (as we have seen) the first or general factor is merely the simple sum or unweighted average of the test-marks. The

[1] The correlation table which was the occasion of Pearson's suggestion itself provides an excellent illustration of this point. The correlations of the three head-measurements with the four limb-measurements are all explicable in terms of a single common factor only ; the two clusters of disproportionately large coefficients thus require only two group factors (or one bipolar factor) to give a very plausible fit (cf. p. 163 above).

[2] Equation (ix) has been termed by Garnett (*loc. cit.*, p. 96, eq. 16) the 'cosine law.' Althougn implicit in Pearson's discussion, the explicit representation of factors as the effect of a rotation of reference-axes in multi-dimensional space is due to Garnett.

correlation of each test with the factor would in that case be estimated by applying equation (xi) to the table of correlations with unity in the diagonal. If, now, in place of unity we substitute the squares of the self-correlations, we introduce a differential weighting, more in keeping with these factor-correlations.

The same formula and the same principles apply, when more factors than the first prove to be statistically significant. Then, if the first factor has been based on a summation of the entire matrix of correlations, the subsequent factors will be 'bipolar,' *i.e.* their saturations will be partly positive and partly negative. These supplementary factors will thus introduce a series of dichotomous classifications: (the first bipolar, for example, may classify both tests and persons as 'verbal' and 'non-verbal' respectively). In dealing with intellectual abilities, however, it is often more instructive to keep all the factors positive (*i.e.* to avoid negative saturations so far as possible), and in that case all the hierarchies except the first will be limited to relatively small clusters or groups of tests. Such factors are called 'group factors,' and, with obvious modifications, the same summation formula (xi) can still be used. Often each group factor will itself be subdivided into narrower groups, and these in turn into sub-groups narrower still.

The Evidence for General and Special Abilities.—A psychological hypothesis that postulates both a general factor and group factors is open to attack from two sides. As we have seen, Spearman and his followers accepted the general factor, but denied the need for group factors; while Thurstone and most American writers accepted the idea of group factors, but questioned the evidence for a general factor. Evidently there are, in all, four alternative hypotheses or models in terms of which we might describe 'the structure of the mind,' and each has its distinctive corollaries.

(i) If (as Thurstone and the faculty psychologists maintained) there is *no* such thing as a general cognitive capacity, but only a limited number of 'primary abilities'—verbal, arithmetical, practical, and the like, then (*a*) all the correlations between the tests in one group (*e.g.* verbal ability) would be positive, and all those between the tests in any other group (*e.g.* practical ability) would be positive, but (*b*) all the cross-correlations between the verbal tests, on the one hand, and the practical tests, on the other, should be approximately zero. (ii) If there is *one* and only one cognitive capacity ('attention' according to Ward, 'discrimination' according to Sully and Spearman), then the correlations between *every* cognitive test should be positive, but, when the effects of the general factor have been eliminated, the residuals should all be approxi-

mately zero.[1] (iii) If (as Galton maintained) we must postulate *both* general *and* special capacities, then, after the effects of the general factor have been removed, the residual correlations between tests in the same group will be positive, but the cross-correlations will now be zero, and there will be a number of such positive groups. (iv) Finally, if, as Thorndike and Thomson maintained, ' the mind, unlike the body, has *no discernible structure*,' [2] then all the correlations should be small, irregular, and devoid of any systematic pattern.

This ' hypothetico-disjunctive ' mode of argument, as the logician would term it, was the method of demonstration I suggested in my own investigations (*e.g.* ' Experimental Tests of General Intelligence,' *Brit. J. Psychol.*, III, 1909, pp. 94–177). Note that, for the second and third arguments to be cogent, the ' general factor ' must be chosen so as to give *the closest possible fit* to the observed coefficients : it should in fact be what I called ' the *highest* common factor ' (*loc. cit.*, p. 165) ; hence the need for the elaborate techniques described in this appendix.

In every research carried out along these lines the results appeared definitely to refute hypotheses (i), (ii), and (iv), and to confirm (iii) (for details see ' Evidence for the Concept of Intelligence,' *Brit. J. Educ. Psychol.*, XXV, pp. 158–77 and refs.). Accordingly, throughout this volume I have taken the third hypothesis for granted.

Need for Research by Teachers.—However, during recent years several psychologists have questioned the validity of the inferences thus drawn.[3] Unfortunately the data which they cite have been collected mainly by research-students, more familiar with academic theories than with the practical study of children in the classroom. Hence there remains an urgent need for research by teachers who can combine first-hand practical experience with a knowledge of scientific techniques ; and for this the teacher of the backward class has not only a special motive, but also unique opportunities.

[1] To prove that the factor is *cognitive*, we must also show that the correlations of cognitive characteristics with affective and conative are approximately zero. This was overlooked by Spearman ; and Garnett contended that the general factor, which many psychologists identified with ' attention,' was really *conative*—a matter of ' application ' or ' will.' Later research has shown this to be untenable.

[2] Cf. G. H. Thomson, *The Factorial Analysis of Human Ability*, p. 303. Since the above was written, nearly all the conflicting schools of factor-analysis have been gradually approaching a closer measure of agreement on the issues that occasioned such sharp dissension in the past.

[3] See, for example, A. W. Heim, *The Appraisal of Intelligence* (1954), W. K. Richmond, ' Educational Measurement : A Critique,' *Brit. J. Psychol.*, XLIV, pp. 221–31. For fuller details regarding factorial methods, see Burt, *Factors of the Mind* (1940), published since the above was written.

APPENDIX IV

THE EXAMINATION OF SPEECH-DEFECTIVES

IN examining or correcting cases of dyslalia (lalling, lisping, and faulty articulation generally) the following are the sounds more especially to be watched. They are arranged in order, according to the frequency with which each is apparently liable to mispronunciation or distortion. After every sound the commonest substitutes are indicated with examples. The results are based on a study of over 400 London children, suffering from slight defects of articulation.

For recording the mispronunciations of children, the teacher should learn and use a scientific notation. The phonetic alphabet of the *International Phonetic Association* is the best.[1] Here, however, since a more scientific symbolism would be unintelligible to most of my readers, I am reluctantly compelled to fall back on the clumsy conventions of English orthography : when ambiguity might arise, the recognized phonetic symbol is added in square brackets.

It will be seen that *most of the sounds erroneously substituted by children who lisp and lall would pass as normal articulations, if not in some other context in English, at any rate in some other language :* the weirdest noises produced by speech-defectives are nevertheless nearly always to be discovered in a foreign tongue. Hence, for exact observation, a training in general and non-English phonetics is exceedingly helpful.

The inquiry plainly shows that there is a certain amount of system about the substitutions. The distortions are by no means so random as they seem. The child may substitute a labial for a dental (or, more precisely, a labio-dental for a linguo-dental, as in 'free' for *three*) ; but both the substituted and the intended sounds are fricatives. Or he may substitute a guttural for a dental ('lickle' for *little*) ; but both are plosives, and the child is merely pressing his palate with the large back of the tongue instead of with the smaller front part. Or he may substitute a plosive for a continuant—*i.e.* for a nasal or a fricative (as t for n or s), but once

[1] For phonetic theory applied to English, see Daniel Jones, *The Pronunciation of English* (Cambridge University Press, 1927), or the smaller volume of Ida C. Ward, *The Phonetics of English* (Heffer, 1929). For a simple description of the more important non-English sounds, see G. Noel-Armfield, *General Phonetics* (Heffer, 1924).

more both the originals and the substitutes are linguo-dentals, the position of the tongue and teeth being practically the same in every case. Similarly, plosives may be turned into the corresponding affricates, nasals denasalized, voiceless sounds vocalized or vice versa. Thus, *in the main, the substitutions are explained, not by similarity of sound, but by similarity of movement.* In different children different types of movement are affected ; nevertheless, in his different substitutions the same child consistently obeys much the same tendency throughout. Accordingly, the mispronunciations could largely be reduced to a series of generalizations somewhat resembling an elaborate version of 'Grimm's law'—the particular type of *Lautverschiebung* operative in each individual depending mainly on what might be called his phonetic type.[1] Thus, just as the phonetician's study of the way in which foreign sounds are produced has helped us to describe more accurately the mispronunciations of the speech-defective, so a study of the mispronunciations of the dull, backward, or very young, might, I believe, do much to explain the phonetic 'laws' which have largely determined the evolution of modern languages from their more primitive forms.

In what follows I have dealt primarily with isolated sounds. But one of the commonest of all simplifications is the elision of a single consonantal sound where several are combined. Here again general rules are often discernible. Most frequently, the vigorous plosive is retained, and the continuant, being more delicately formed, is dropped. This is particularly the case where the control is muscular rather than auditory or visual and at the same time somewhat defective : *e.g.* 'tummy' for *stomach*, 'p'ease' for *please*, 'ting' for *string*, 'sec'etary' for *secretary* (in 'diptheria' for *diphtheria* the visible spelling influences the result). Where the control is mainly auditory, and there is no defect of muscular control, the plosive, especially if voiceless and initial, is dropped even in

[1] Cf. p. 376 above. There it was pointed out that the changes of a cockney speech-defective were in some ways analogous to those characteristic of modern English and modern German : the child seems to be, as it were, carrying further the phonetic tendencies of his race. It would be interesting to inquire whether there are appreciable differences in the mispronunciations of speech-defectives of different countries, and if so how far they are in keeping with the phonetic tendencies of each particular nation. In German the commonest mispronunciations are said to be those of r, g, and l : these recur so frequently that medical writers have invented a special term for each—*Rhotacismus*, *Gammacismus*, and *Lambdacismus*, respectively. Lisping, and the mispronunciation of fricatives generally, seem far rarer in German than in English. It is interesting to compare this with the difficulty that a German generally experiences in pronouncing an English th : if this is a difficult or unusual sound for him, he is not likely to substitute it for s : hence the defect popularly described by the English teacher as 'lisping' is rarely heard, so it is said, in German schools .On the other hand, the Englishman has considerable difficulty in pronouncing German fricatives.

normal pronunciation, and the second, especially if fricative, is usually preserved: *e.g.* 'cloze' for *clothes*, 'sychology' for *psychology*, 'thisis' or 'tisis' for *phthisis*, 'bo'sun' for *boatswain*, ''ank you' for *thank you*. *t* is dropped even *after* a fricative, as in *soften*, *postpone*, and most words in -stle, -sten (*castle*, *listen*, etc.). 'I as'd him,' however, is not permitted; but 'bla'guard,' 'em'ty,' 'Chris'mas,' 'han'kerchief,' 'We'n'sday' are.

Sounds Commonly Mispronounced

Arranged in order of frequency of mispronunciation

(In each case the first letter—the capital—represents the correct sound: the letters following the dash indicate the sounds most commonly substituted.)

1. Unvoiced TH [θ]—f, s, t, occasionally h or a glottal stop[1] [ʔ], or omitted: as 'fum,' 'sum,' or 'tum,' for *thumb*; 'I hink so' for 'I think so'; 'froo sick and sin' for 'through thick and thin.'

2. R—w, or rather v^w, [β] (bilabial v, especially after another labial), v, y, l, [x] (voiceless velar fricative, especially after th), or omitted, especially after another consonant: *e.g.* 'gween,'[2] 'gveen,' 'gyeen,' 'gleen,' or 'geen,' for *green*; 'tyied' or 'chide' for *tried*. Owing to assimilation different sounds may be substituted by the same child according to the context of the consonant: *e.g.* 'Wose is velly bad. . . . This one's geen and that one's yed.'

3. S—th, t, sh, ts, [l̥] (unvoiced l as in Welsh ll), [n̥] (unvoiced n—often exaggerated into a slight snort), [ŋ̊] (unvoiced ng), h (often exaggerated into a strong pharyngeal fricative), glottal stop [ʔ], or omitted: *e.g.* 'thikth,' 'tik,' 'shiksh,' 'tsits,' 'l̥ikl̥,' 'n̥ikn̥,' 'hikh,' or 'ʔikʔ,' for *six*.[3]

[1] The glottal or guttural stop is a stop or catch produced by closing the glottis with the vocal chords. When the breath is released a slight explosive sound is heard rather like a repressed cough or the grunt made in an abdominal effort. In speech the traveller abroad is familiar with it from the peculiar hard attack with which the North German utters all stressed syllables commencing with a vowel; the scholar knows it as the 'soft breath' marked over initial vowels by the ancient Greek—the 'hard breath' corresponding to our aspirate h.

[2] The mispronunciation of r, which is popularly transcribed with a w, is usually a very weak v with the tongue raised at the back. If the lisper is asked to pronounce 'rate' and 'wait,' a distinct difference will be noticeable; and if the teacher watches the child's mouth, he will see that the lips are spread for the false r and rounded for the correct w, and that in the former case the lower lip often touches the upper teeth, and in the latter the upper lip. Occasionally a sort of rolled bilabial is substituted (the shooing or booing noise often represented by b.r.r.r). The velar fricative [x] or uvular (Northumbrian or Parisian) ʀ, and even the burred inverted (Western) r [ɹ], are sometimes found as spontaneous defects: more commonly, of course, they are a dialectal mannerism, picked up from provincial speech.

[3] These different forms of lisping can often be explained by the nature of the deformity to which they are due, and have consequently received special technical names. For example, with an 'open bite'—*i.e.* upper incisors not closing down upon the lower—the tongue is apt to be placed against the teeth (producing a fairly clear th—*sigmatismus addentalis*, as it is sometimes rather pompously termed) or even between the teeth (producing a more clumsy th—interdental lisping or *sigmatismus interdentalis*). If the teeth are high on either side, the air escapes laterally between

4. Voiced TH [ð]—v, z, d, or [θ] unvoiced th ; as 'ven,' 'zen,' 'den,' for *then*, 'wiθ' for *with*.

5. SH—t, s, ts, ch, l, or [l̥] : *e.g.* 'tirt,' 'sirt,' 'tsirt, 'chirt,' 'lirt,' or 'l̥irt,' for *shirt*.

6. Y—l, sometimes r, more frequently omitted : *e.g.* 'lellow' for *yellow* ; 'less' or 'ess,' for *yes*.

7. Z—th, ds, d, s, or j : *e.g.* 'pleathe,' 'pleads,' 'pleace,' 'pead,' 'peaj,' for *please*.

8. G—d, sometimes gy or [ɟ] (the voiced palatal plosive), occasionally k : *e.g.* 'dun,' 'gyun,' for *gun* ; 'kiv' for *give*.

9. ZH [ʒ]—z or d : *e.g.* 'Dzohnny' or 'Dohnny' for *Johnny* (J in English stands for two sounds fused, d and zh), 'mezzer' for *measure*.

10. K—t, sometimes ky, [ç] the unvoiced palatal plosive, or [kx] (x being the phonetic symbol for the unvoiced velar fricative, or ach-laut) : 'tat' for *cat* ; 'tate' for *cake*. Such mispronunciations as 'I'll ast him' (for *ask*) are usually dialectal ; 'kyind' for *kind*—as Victorian novels show—was a common cockneyism : it is now more frequently heard as a childish palatalization of the hard gutturals. For pure plosives, especially k and t, an affricate is very characteristic of the dull Londoner. (Affricates consist of fricative sounds following simple plosives and more or less fused with them ; they are due to slow release of the tongue.)

11. NG—n, nd, nk, g : *e.g.* 'sinnin,' 'sindin,' or 'siggig,' for *singing*. 'Nothink' for *nothing* is usually a cockneyism rather than a speech-defect.

12. CH (*i.e.* TSH)—ts, s, t, hy (or rather [hj]) and [ç] (the German ich-laut) : *e.g.* 'tsirts,' 'surce,' 'tirt,' 'hyirç,' for *church*.

13. V—b, d, occasionally f or initial w : *e.g.* 'glub' or 'gud' for *glove* ; 'berry,' 'fe'y' or 'welly,' for *very* ; cf. 'spell it with a "wee"' for *vee*—a change now chiefly heard among foreigners, *e.g.* the negro and the Chinese.

14. L—y, especially after a consonant : *e.g.* 'yeg' for *leg* ; 'gyuv' for *glove* ; aw, ow, or oo, before a consonant, 'miook' for *milk*, 'row-way' for *railway*, 'aw ri' for *alright* ; w, and sometimes t, d, or s, before a vowel ; r or a velar or uvular fricative, when initial ;

them (producing the unvoiced Welsh l—*sigmatismus lateralis*). If the naso-pharynx is not closed, the s is transformed into an unvoiced ng, or a kind of nasal snort (*sigmatismus nasalis*) : occasionally a glottal stop is substituted or the s omitted altogether. If the front teeth project or are entirely missing, a sound approximating to sh [ʃ] is often produced.

It is singular that Lapage, in his list of the consonantal substitutions observed by him among mentally deficient children in Manchester, omits the commonest and most notorious lisp of all, namely, the substitution of th for s (*Feeblemindedness in Children of School Age*, 1911, p. 306). Perhaps this substitution is rarer in the north of England than in the south.

nasal (n or ng) especially when following a plosive; but most often the l sound is completely omitted. *E.g.* 'Rikŋ' for *little*, 'Rabm' for *label*. With these rare mispronunciations 'cockle' and 'cotton,' 'buckle' and 'button' may be almost indistinguishable—[koʔŋ] and [bvʔn] doing duty for such pairs. The various pronunciations of *alms*, *almoner*, *aumbry* (for *almonry*, though from a different root) illustrate the tendency to vocalize the l; and *banister* (a corruption of *baluster*), the tendency to nasalize it.

15. T—k, s, ts (or other affricate), st, r, glottal stop, or omitted: *e.g.* 'ickaw,' 'lirraw,' for *little*; 'sap,' 'tsap,' 'stap,' or 'sthap,' for *tap*—a type of mispronunciation often produced by a markedly undershot jaw.

Not infrequently all dental sounds—d, n, s, as well as t—are articulated by placing the tip or blade of the tongue on the edge of the upper teeth instead of against the gum-ridge, thus producing a kind of exaggerated French dental, and giving the untrained ear the impression that the child is substituting th. The change may be scarcely noticeable if confined to certain sounds in certain contexts: but when systematic (as in many idioglossic cases) it has almost the effect of a lisp. The total omission of t before an unaccented syllable, or the substitution of an almost inaudible glottal or guttural stop [ʔ], is extremely common among London children from the poorer classes, as it is in Glasgow and other parts of Scotland; *e.g.* 'frighʔened of a liʔaw waʔer.'[1] This is perhaps a peculiarity of dialect rather than a speech-defect: it is common in cases of adenoids and naso-pharyngeal obstruction, and appears with special frequency among children showing other substitutions, and by them may even be used before accented syllables. The sound ts (or a similar affricate) is commonly heard as a Cockney mispronunciation (*e.g.* 'tsiu 'n tsiu er fower').[2] 'Tsh' for 'ti' is sometimes a vulgarism, sometimes a correct pronunciation: 'I'll 'it sher' (for *hit you*) is vulgar; 'naytsher' (for *nature*) is permissible if not correct; while no one would say 'na-ti-on.'[3]

16. W—y, sometimes m, or omitted: *e.g.* 'ent,' 'yent,' or 'ment,' for *went*; v for *w*—as in 'Samivel Veller,' or 'vere is Villie Vallenstein'—is chiefly met with as a dialectal peculiarity of the Cockney (now fast dying out) or as a lisp of the German-speaking Jew.

[1] For 'frightened of a little water.'

[2] 'Two and two are four.'

[3] The Southern English normally introduce a marked aspirate after unvoiced plosives, like t, p, and k. (When I pronounce 'park' in front of a lighted candle, the flame is puffed out; when a Frenchman says 'parc,' the flame hardly quivers.) In the Cockney the lazy articulation and slow release of the tongue gives this aspirate a ricative sound near the original point of contact: as noted in discussing the k-sounds, this laxity of articulation is exceedingly characteristic of the dull Londoner.

17. F—t, p: *e.g.* 'tide' or 'pibe' for *five.*

18. N—d, l, m, occasionally ng: *e.g.* 'peddy,' 'pelly,' or 'pengy,' for *penny*; 'ngice goggy' for *nice doggy.* The careless assimilation of a nasal to the preceding plosive—'opm' or 'sebm' for *open* or *seven*—is common among those who are childish in their talk, but so widespread as scarcely to count as a speech-defect.

19. M—b: *e.g.* 'bubby' for *mummy.* The denasalizations of n and m are characteristic of children with some form of nasal obstruction such as adenoids, and of most of us when we have a bad cold. Popularly it is called 'talking through the nose'; really it is the reverse.

20. D—t, g, glottal stop, dz, or other affricate, or omitted: *e.g.* 'pattle,' 'paggle,' or 'pa'le,' for *paddle*, 'dzog,' or 'dsog,' or 'dyog' (approximately), for *dog.*

21. P—t, d, glottal stop, or [Φ] unvoiced bilabial fricative: *e.g.* 'soat' for *soap*; 'dader,' 'ʔaʔer,' or something that sounds like 'pfipfer,' for *paper*; 'pfrize' for *prize.* Difficulty with this and other labials is not uncommon in children with overshot jaws, who find it hard to protrude and approximate both lips.

22. B—p or d: *e.g.* 'poy' or 'doy' for *boy*; 'dady' for *baby.*

The teacher who examines this collection, and compares it with similar data from his own experience, will easily verify the two conclusions I have drawn in the text.

To take the practical conclusion first: it appears that nearly all the mispronunciations characteristic of a definite speech-defect are mispronunciations of consonants. Now the pronunciation of a vowel is a matter of muscular posture—of a contraction relatively sustained; the pronunciation of a consonant is an effect of muscular movement—of a quick, complex, interpolated change. The vowel, being prolonged and invariably voiced, is easily heard by the ear of the producer: a consonantal noise is less easy to distinguish. Thus, a child, in effect, copies his vowels by ear, but trusts more to his muscles to produce the consonants.

It is true that teachers complain almost as frequently of their pupils' mispronunciation of vowels. When a child's speech differs from the hearer's it is the difference in vowel-sounds that the untrained ear most easily remarks. Nevertheless (except for the nasalizations due to cleft palate and the like) the mispronunciation of vowels is characteristic rather of a dialect than of a defect—of regional dialect, as in so-called 'provincialisms,' and of class dialect, as in so-called 'vulgarisms.' No doubt such peculiarities are especially difficult to eradicate in the dull. Yet it may be questioned whether it is necessary, or even desirable, to enforce on every

child a set of speech conventions that are really distinctive of a class or a district to which the child himself may not belong. The man brought up on books commonly introduces a third form of control—that of the eye: his analysis of speech is apt to be based more on the printed than on the spoken word. Thus many of the pronunciations on which teachers insist in the classroom are not true pronunciations, but erudite mispronunciations, due to a mistaken notion that speech and spelling should correspond: (*e.g.*, 'picture' with a clear *u*, 'mountain' with a clear *ai*, 'often' with an audible *t*, 'bad dog' with the first *d* exploded, 'Hunt has hurt his head' with aspirated *h*'s in unaccented syllables). To say 'fore-head'—with each component syllable distinct—is surely as much a manifestation of pedantic ignorance as to say 'boat-swain.' The best that can be said in justification of such efforts is that they sometimes help the dullard to spell more accurately.[1]

The second point is of theoretical interest rather than practical. The teacher who studies the above list in the light of his philological knowledge will see that nearly all the changes can be paralleled by well-known tendencies that have marked the development of our language in the past and still mark our normal speech to-day. He will see that the speech-defective who says 'velly' and 'opm' for *very* and *open* is merely exemplifying the two tendencies which turned *peregrinus* into 'pilgrim.' The child who says 'yarden' for *garden* is repeating the process that turned 'garth' into 'yard.' To say 'shirt' (or more accurately 'sçirt') for *skirt* is a common type of speech-defect; yet the word 'shirt' is itself by etymology simply another way of pronouncing 'skirt.' Similarly the Southron says 'church' while the Scot keeps to the older 'kirk.' And the final stage in the mispronunciation of gutturals is illustrated by contrasting the English 'knight' with the German 'Knecht': in the English both gutturals are dropped altogether.

Once again, the child who says 'hikh' for *six* is dubbed a speech-defective; but the Latin 'semi' (here the older form) appears as 'hemi' in Greek (a 'hemisphere' is a 'semisphere'). Latin and Greek, indeed, provide many well-known illustrations of the way in which a sibilant is first lisped, then labialized, and finally dropped: the *sr-* of Indo-European roots, for example, regularly becomes 'thr-' and later 'fr-' in Latin and 'hr-' in Greek: (cf. *frigus* and ῥῖγος). Similarly, the older *the-* surviving in such Greek words as θῆλυς, θῆσθαι, becomes 'fe-' in the Latin

[1] How to deal with these milder deviations from standard English, as well as the whole problem of speech-education, is admirably discussed from the standpoint of the practical teacher in Professor H. C. Wylde's *Teaching of Reading* (Murray, 1908).

counterparts 'femina' and 'fellare.' The complete elision of the difficult *s* is notorious in French and is found in such vulgarisms as 'ain't' for *isn't*. The elision of the difficult *w* is illustrated by such words as 'bulwark' and 'Dulwich.'

The process which turns the 'dark *l*,' when followed by a second consonant, into a mere 'darkening' of the preceding vowel (thus turning *milk* into 'miook') is the process which turned the past tense of 'will'—*willed*—into 'wou'd.' The nasalization of the liquid *l* ('buck'n' for *buckle*)—rare in this country except in speech-defectives—was a distinctive characteristic of the Doric dialect: every schoolboy knows how Theocritus' shepherd regularly said ἦνθον for ἦλθον, and the like. When the consonant precedes the *l*, that consonant itself becomes rather hard to produce, and so, as we have seen, easily becomes modified if the *l* is retained: 'tlock' for *clock*, 'dlad' for *glad*, is a common form of lalling in the South of England, and is there regarded as a form of speech-defect; in the North it is, in many places, the normal pronunciation.

These analogies form but one of many instances which show how the peculiarities of the subnormal child, sympathetically studied for themselves from a psychological standpoint, will cast a flood of light upon the natural tendencies of the human mind, and how a knowledge of those tendencies in other fields will in turn explain much that would otherwise be so puzzling in the 'mistakes' and the 'defects' of the backward pupil.

LIST OF REFERENCES FOR FURTHER READING

1. *Child Psychology and Education*

Breckenridge, M. E., and Vincent, E. L., *Child Development.* Saunders, 1949.

Burt, Cyril, *How the Mind Works* (3rd ed.). Allen & Unwin, 1958.

Carmichael, M. (ed.), *Manual of Child Psychology* (2nd ed.). Chapman & Hall, 1954.

Dent, H. C., *The Education Act, 1944* (6th ed.). University of London Press, 1958.

Isaacs, S., *The Children We Teach.* University of London Press, 1950.

London County Council, *Special Services of Education in London.* University of London Press, 1929.

Valentine, C. W., *Psychology and its Bearing on Education.* (2nd ed.), Methuen, 1960.

Valentine, C. W., *The Normal Child and his Abnormalities.* Penguin Books, 1956.

2. *The Subnormal Child*

Burt, Cyril, *The Subnormal Mind* (3rd ed.). Oxford University Press, 1955.

Burt, Cyril, *The Causes and Treatment of Backwardness* (4th ed.). University of London Press, 1956.

Schonell, F. J., *Backwardness in the Basic Subjects* (4th ed.). Oliver & Boyd, 1948.

Segal, C. S., *Backward Children in the Making.* Muller, 1949.

Abel, T. M., and Kinder, E. F., *The Subnormal Adolescent Girl.* Columbia University Press, 1942.

Burt, Cyril, *The Young Delinquent* (4th ed.). University of London Press, 1948.

Hall, M. Barton, *The Psychiatric Examination of the School Child.* Arnold & Co., 1914.

3. *Mental and Scholastic Tests*

Burt, Cyril, *Handbook of Tests for Use in Schools* (2nd ed.). Staples Press, 1948.

Schonell, F. J., and Schonell, F. E., *Diagnostic and Attainment Testing*. Oliver & Boyd, 1950.

Terman, L. M., and Merrill, M. A., *Measuring Intelligence*. Harrap, 1947.

Valentine, C. W., *Intelligence Tests for Young Children* (4th ed.). Methuen, 1950.

Vernon, P. E., *Measurement of Abilities* (2nd ed.). University of London Press, 1956.

4. *Treatment and Training*

Armstrong, J. M. A., *Projects and their Place in Education*. Pitman, 1950.

Arthur, G., *Tutoring as Therapy*. New York Commonwealth Fund, 1946.

Atkinson, M., *The Junior School Community*. Longmans, 1949.

Barons, P. A., *Practical Suggestions for Training Backward Children*. Charles, 1935.

Barons, P. A., *Backwardness in Schools*. Blackie, 1938.

Blair, G. M., *Diagnostic and Remedial Teaching*. Macmillan, 1956.

Board of Education, *The Education of Backward Children*. H.M. Stationery Office, 1937.

Cheshire Education Committee, *The Education of Dull Children at the Primary Stage*. University of London Press, 1956.

Cleugh, M. F., *The Slow Learner*. Methuen, 1957.

Duncan, J., *The Education of the Ordinary Child*. Nelson, 1949.

Fernald, G. M., *Remedial Techniques in Basic School Subjects*. McGraw-Hill, 1943.

Hamley, H. R., and Others, *The Education of Backward Children*. Evans, 1947.

Inskeep, A. D., *Teaching Dull and Retarded Children*. Macmillan, 1932.

Kennedy-Fraser, D., *Education of the Backward Child*. University of London Press, 1932.

Kirk, S., and Johnson, G. O., *Educating the Retarded Child*. Houghton Mifflin, 1951.

Ministry of Education, *School Health Services and Handicapped Pupils Regulations*. H.M. Stationery Office, 1953.

Ministry of Education, *Special Educational Treatment* (No. 5). H.M. Stationery Office, 1946.

Ministry of Education, *Education of the Handicapped Pupil* (No. 30). H.M. Stationery Office, 1956.

National Association of Mental Health, *The Social Adaptation of E.S.N. School Leavers*, 1953.

National Society for the Study of Education, *Fortyninth Yearbook*, Part II, *The Education of Exceptional Children*. University of Chicago Press, 1950.

Robertson, R. K., *The Treatment of the Backward Child*. Methuen, 1950.

Rogers, C. R., *The Clinical Treatment of the Problem Child*. Boston, Houghton Mifflin, 1939.

Taylor, E. A., *Experiments with a Backward Class* (2nd ed.). Methuen, 1947.

Wills, W. D., *The Hawkspur Experiment*. Allen & Unwin, 1941.

Wills, W. D., *The Barns Experiment*. Allen & Unwin, 1947.

Winterbourn, R., *Educating Backward Children in New Zealand*. N.Z. Council for Educational Research, 1944.

5. *Special Subjects*

Brideoake, E., and Groves, I. D., *Arithmetic in Action*. University of London Press, 1939.

Duncan, J., *Backwardness in Reading*. Harrap, 1953.

Gates, A. I., *The Improvement of Reading*. Macmillan, 1949.

Harris, A. J., *How to Increase Reading Ability*. Longmans, 1940.

Keir, G., *Adventures in Reading*. Oxford University Press, 1951.

Martens, E. H., *Guide to Curriculum Adjustment for Mentally Retarded Children*. Washington, U.S. Government Printing Office, 1936.

Ministry of Education, *Reading Ability : Suggestions for Helping the Backward*. H.M. Stationery Office, 1950.

Monroe, M., and Backus, B., *Remedial Reading*. Harrap, 1937.

Schonell, F. J., *The Psychology and Teaching of Reading*. Oliver & Boyd, 1945.

Schonell, F. J., *Essentials in the Teaching and Testing of Spelling*. Macmillan, 1938.

Schonell, F. J., *Diagnosis and Remedial Teaching in Arithmetic*. Oliver & Boyd, 1957.

Williams, D., *A Realistic Approach to Number Teaching*. Oxford University Press, 1948.

INDEX OF NAMES

INDEX OF SUBJECTS

STATE INSTITUTE OF EDUCATION

THE BACKWARD CHILD

One of the most urgent tasks in the field of education at the present day is the treatment of the educationally subnormal. The fourth and fifth editions of *The Backward Child* have been thoroughly revised to meet the changes introduced by the Education Act of 1944 and by the later regulations dealing with this problem; and the results of later research have been incorporated in the text.

The plan of the work is similar to that adopted in Sir Cyril Burt's earlier book, *The Young Delinquent*. Modern methods of studying the subnormal child are explained, and the testing of general intelligence, school attainments, and special capacities is described and illustrated. The various causes of backwardness are then considered, and the treatment of special types – the dull, the merely retarded, the nervous, the lefthanded, the stammerer – is discussed in detail. Practical questions, such as the organization of school classes and the modifications of teaching methods appropriate to backward children, are fully examined in the light of recent experience.

UNIVERSITY OF LONDON PRESS LTD